Biological Monitoring
Goldsborough Creek, Washington
2002 Spawning and Macroinvertebrate Surveys
Data Report

-FINAL-

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CONTENTS

FIGURES

TABLES

APPENDIX TABLES

1. INTRODUCTION

Goldsborough Creek, located in the foothills of the southern Olympic Peninsula, Washington, is the site of a Section 206 Restoration Project conducted under the authority of the Water Resources Development Act by the U.S. Army Corps of Engineers, Seattle District (USACE). The Goldsborough Creek Restoration Project entailed the removal of a dam located at River Mile (RM) 2.3. The stream in the vicinity of the dam was stabilized to establish a gradual drop over several thousand feet of stream (Tetra Tech 1999). The objective of the project is to re-establish an upstream and downstream connection for anadromous salmon between upper Goldsborough Creek and South Puget Sound (USACE 1999a). The Goldsborough Creek Project was completed in September of 2001.

Goldsborough Creek is located near the City of Shelton, south of Hood Canal in Mason County, Washington. Goldsborough Creek (WRIA 14.0035) is approximately 14 mi long and has a drainage basin of approximately 55 mi^2 (Williams et al. 1975; USFWS 1999; USACE 1999a). The headwaters for Goldsborough Creek originate from several small spring-fed lakes that supply water to the North and South forks (Figure 1). Mean monthly discharge ranges from a low of 20 cfs in September to 400 cfs in February (mean annual discharge = 117 cfs) (Williams et al. 1975). Most of the upper drainage basin is composed of second growth timber, while the lower basin (i.e., downstream from RM 2) flows through the City of Shelton before emptying into Oakland Bay. The two largest tributaries, Coffee and Winter creeks, are located near RM 1.7 and RM 9.0, respectively. Coffee Creek is approximately 2.1 mi long and enters Goldsborough Creek near Shelton; Winter Creek, 4.5 mi long, is a tributary to the North Fork of Goldsborough Creek near Wells, Washington.

The original dam on Goldsborough Creek was constructed in the late 1800s by Satsop Railroad to store logs before they were transported downstream to Shelton (Seavey 1999). The updated dam, a 14-ft-high timber-wall dam, was built in 1932 by Rainier Pulp and Paper Company to supply water to their pulp mill that was located in Oakland Bay (Figure 2). The original dam was constructed with a fishway; however, it became inoperable over time due to erosion downstream from the dam. Additional structures (i.e., sheet pile weir and timber piles) were added to the dam to create a “four-step” structure (USACE 1999a). The spillway discharged onto a shallow, concrete-lined pool/step and then dropped another 15 ft into a plunge pool (Figure 2). Modifications to the original structure in 1932 also included a new fishway located on the left side of the stream. Total vertical displacement through the dam from the crest to the plunge pool was approximately 35 ft. Like the old facility, the updated fishway appeared to prevent upstream migration of chum salmon (*Oncorhynchus keta*) and restrict the upstream movement of coho (*O. kisutch*) under certain hydraulic conditions (Seavey 1999; USACE 1999a).

The Goldsborough Creek Restoration Project consisted of the following tasks: removal of the timber pile and concrete structure; excavation of approximately 25,000 yd^3 of sediment deposited upstream of the dam; placement of fill material downstream of the dam to re-establish channel gradient; construction of weirs within the area currently occupied by the dam to control gradient and provide velocity refugia for upstream migrating salmonids; and bank protection/revegetation activities. The project was a collaborative effort between the USACE and Simpson Timber Company under Section 206 of Water Resources Development Act. Feasibility studies were completed in 1999 and the project received approval in September 1999 by the USACE, North Pacific Division. The project construction was completed by the fall of 2001 (Figure 3). Bank protection and revegetation activities are still ongoing.

There are 36 weirs in the Project Area (i.e., downstream-most weir to upstream-most weir) arranged in six groups of five and one group of six (the downstream-most weir group). There is approximately 35 ft between individual weirs, and each weir group is separated by 100 to 275 linear ft of stream channel. The overall slope of the Project Area is designed to be 2.3%, with approximately 3.6% slope within each weir (USACE 1999b). Each weir is designed to provide unhindered upstream and downstream fish passage at varying flow levels (Figures 4 and 5). Each weir is designed to have a maximum 12 inch elevation drop to ensure fish passage. During project construction Goldsborough Creek was routed around the Project Area through a temporary bypass pipe. A stilling basin was placed at the bypass pipe outlet to serve as a sediment trap. After the bypass pipe was in place, a concerted effort was made to collect and transport as many fish as possible out of the dewatered Project Area. When the pipe was removed, the stilling basin was left to continue to filter sediments being flushed downstream by the return of the creek to its channel.

The USACE contracted with R2 Resource Consultants (R2), to conduct biological monitoring in Goldsborough Creek. The primary objective of this study is to obtain pre- and post-dam removal data on the timing and distribution of salmon spawning in Goldsborough Creek. Specifically, the scope of work identified three tasks:

- Conduct spawner surveys in Goldsborough Creek during the chum, coho, and Chinook (*O. tshawytscha*) salmon spawning season;

- Collect benthic macroinvertebrates from three index reaches in Goldsborough Creek for comparison with pre-dam removal metrics; and
- Prepare a biological monitoring data report, describing both the number of fish observed as well as the pre- and post-dam removal benthic macroinvertebrate information collected from Goldsborough Creek in 2002.

The following report describes the methods and results of the biological monitoring. We have included descriptions of the physical conditions (water clarity, water temperature, and stream discharge) in the survey reaches and incorporated the results of previous adult spawner surveys to facilitate comparisons over time. This report will help assess the success of the Goldsborough Creek Restoration Project relative to upstream fish passage.

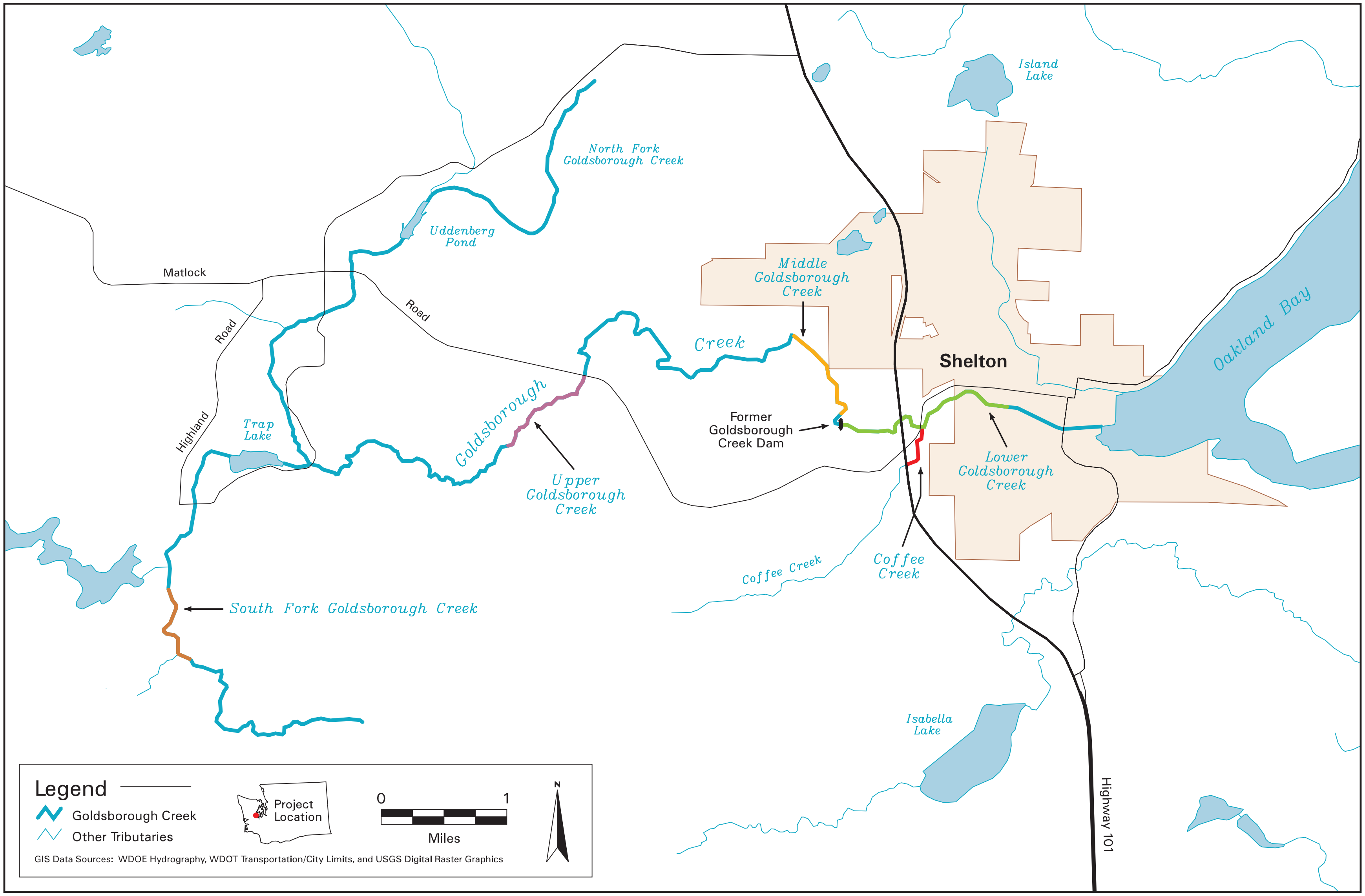


Figure 1. Goldsborough Creek drainage basin, Mason County, Washington.

Figure 2. Updated Goldsborough Creek Dam, 1999, Mason County, Washington.

Figure 3. Goldsborough Creek Restoration Project Area during construction, August 2001, Mason County, Washington.

Figure 4. Goldsborough Creek Restoration Project Area, low flow conditions, Mason County, Washington.

Figure 5. Goldsborough Creek Restoration Project Area, high flow conditions, Mason County, Washington.

2. BIOLOGICAL SETTING

Goldsborough Creek supports populations of both resident and anadromous fish species. Chum, coho, and Chinook salmon, coastal cutthroat trout (*O. clarki clarki*) and steelhead (*O. mykiss*) are known to spawn in Goldsborough Creek (Williams et al. 1975; Bernard 1999), while bull trout *(Salvelinus confluentus*) are present in many drainages on the Olympic Peninsula (Spalding 1997). The following section describes key life history characteristics and residency periods for each of the aforementioned species.

2.1 CHINOOK SALMON

Chinook salmon are the largest of all Pacific salmon, and can weigh over 100 pounds, however the average weight is closer to 22 pounds. Chinook salmon, the least abundant of the five Pacific salmon species, were historically found from the Ventura River, California to Point Hope, Alaska (Meyers et al. 1998). Presently, spawning populations of Chinook exist from the San Joaquin River, California to the Kotzebue Sound, Alaska (Healey 1991). Chinook salmon are differentiated into two primary juvenile behavioral forms, ocean-type and stream-type, based on their pattern of freshwater rearing. Juvenile ocean-type Chinook salmon migrate to the marine environment during the first year of life, generally within three to four months of emergence (Lister and Genoe 1970). Juvenile stream-type Chinook salmon rear in freshwater for a year or more before outmigrating to the ocean. The population of Chinook salmon in a single river system may exhibit variations in these freshwater rearing strategies depending on annual variations in food supply, water temperature and other environmental factors. Differences between these life history patterns are accompanied by differences in morphological and genetic attributes (Myers et al. 1998). Chinook salmon classification is further divided by the timing of upstream migration (e.g., spring or fall/summer runs).

The principal stock of Chinook salmon present in Goldsborough Creek is summer/fall ocean-type Chinook. Adult summer/fall Chinook migrate upstream from early August to mid-November. Spawning takes place from mid-September through mid-November. The juveniles may migrate to the ocean in the first three months of life. Ocean-type Chinook depend heavily on estuaries for juvenile rearing to achieve a larger size before moving off-shore. Juvenile Chinook (n = 105; mean FL = 79 mm) were captured in a screw trap operated in Goldsborough Creek near RM 0.3 in 2000 (Celedonia et al. 2000).

Goldsborough Creek summer/fall Chinook are part of the Puget Sound Evolutionary Significant Unit (ESU). Overall, abundance of Chinook salmon in this ESU has declined substantially, and both long- and short-term abundances are on predominantly downward trends. These factors have led to this ESU as being listed as threatened under the ESA (64 *Fed. Regist*. 11481:11520).

2.2 COHO SALMON

Coho salmon are one of the most popular and widespread sport fishes found in Pacific Northwest waters. Coho populations exist as far south as the San Lorenzo River, California and north to Norton Sound Alaska (Sandercock 1991). Goldsborough Creek coho appear to be typical of Puget Sound stocks with regard to their life histories; eighteen months in freshwater followed by eighteen months in saltwater (or up to three years) (Weitkamp et al. 1995). Juvenile coho salmon may extend their freshwater rearing period for up to two years or more (Sandercock 1991). Adult coho return and migrate upstream from early September through late January. Spawning occurs from mid-November through late January. All accessible reaches are used for spawning, with mainstem spawning typically heaviest in braided channel reaches.

There have been substantial releases of hatchery-origin coho salmon fry and use of remote site incubators upstream of the Goldsborough Creek Dam starting in 1955 (Weitkamp et al. 1995). Over the years, seven different stocks were used with the majority of the planted coho salmon originating from the George Adams (3.3 million) and Minter Creek (3.2 million) hatcheries. The total number of fish planted between 1955 and 1993 was 6.9 million fish. Between 1993 and 1998 about 100,000 coho salmon fry were stocked annually from Minter Creek and a remote site incubator with 30,000 eggs has operated annually since 1995 (Baranski 1999). However, Washington Department of Fish and Wildlife (WDFW) and the Squaxin Island Tribe have agreed to stop all supplementation activities in Goldsborough Creek during the 8 to 10 year post-dam removal monitoring period. Baranski (1999) provided adult coho spawner count data from 1978 to 1999 for the index reach upstream of the dam. These data show an average of 419 fish per year (expressed as “fish-days”) with a range from 0 to 1,259 coho, averaging 115 coho for the last 10 years. Juvenile coho (n = 4,963; mean FL = 113 mm) were captured in a screw trap operated in Goldsborough Creek near RM 0.3 in 2000 (Celedonia et al. 2000).

Goldsborough Creek coho stocks are considered part of the Puget Sound/Strait of Georgia ESU. Continued loss of habitat, extremely high harvest rates, and a severe recent decline in average spawner size are substantial threats to remaining native coho populations in this ESU. Currently, this ESU is not listed as threatened or endangered.

2.3 CHUM SALMON

Chum salmon, known for the large teeth and calico-patterned body color of spawning males, have the widest geographic distribution of any Pacific salmonid (Johnson et al. 1997). In North America, chum range from the Sacramento River in Monterey, California to Arctic coast streams (Salo 1991). Chum salmon typically return to tributaries in October and November and spawn in the lower reaches of rivers in from early December to early February (WDFW et al. 1994). Juvenile chum salmon, like ocean-type Chinook, have a short freshwater residence and an extended period of estuarine residence, which is the most critical phase of their life history and often determines the size of subsequent adult returns (Johnson et al. 1997).

Spawning surveys conducted in the mid-1970s found few fall chum salmon, however, recent returns to Goldsborough/Shelton Creek combined have totaled between 200 and 16,000 fish and appears to be stable (WDFW et al. 1994). Based on counts conducted in the index reach below the former dam since 1987, the average spawner count (expressed as “fish-days”) is 3,872, ranging from 405 to 14,479 fish per year. From 1995 to 1998, high fall flows resulted in poor estimates of chum escapement. Shelton Creek chum are independent of Goldsborough Creek chum salmon, but the two stocks were combined by WDFW based on geographic proximity. Genetic stock identification (GSI) indicates that this combined stock is distinct from other South Puget Sound stocks. Juvenile chum (n = 692) were captured in a screw trap operated in Goldsborough Creek near RM 0.3 in 2000 (Celedonia et al. 2000).

Goldsborough Creek chum salmon are included in the Puget Sound/Strait of Georgia ESU. Commercial harvest of chum salmon has been increasing since the early 1970s throughout this ESU. This increased harvest, coupled with generally increasing trends in spawning escapement, provides compelling evidence that chum salmon are abundant and have been increasing in abundance in recent years within this ESU (Johnson et al. 1997). The National Marine Fisheries Service concluded that this ESU is not presently at risk of extinction, and is not likely to become endangered in the near future (63 *Fed. Regist*. 11778).

2.4 BULL TROUT

Bull trout are native to Pacific Northwest waters, historically occurring from the McCloud River in Northern California to the Yukon River in Northwest Territories, Canada. Bull trout are now considered to be extinct in northern California, and shrinking in distribution throughout its former range. The taxonomic status of bull trout have been confused with that of Dolly Varden. Bull trout were differentiated from Dolly Varden in 1978 (Cavender 1978) and recognized as a separate species by the American Fisheries Society in 1980. Both species are native salmonids and members of the Genus Salvelinus. The species are similar in coloration, morphology, and life history, making distinction between the two species difficult without the use of electrophoretic samples or measurements of morphometric characteristics (WDFW 1997). The state of Washington has established identical protective measures and management for the two species (WDFW 1997). Historically, bull trout were thought to be distributed primarily inland as a resident species; however, recently most inland populations have been determined to be Dolly Varden and anadromous populations as bull trout. Spawning in most bull trout populations occurs during the fall, mainly in September and October. The eggs incubate and hatch in late winter or early spring. Juvenile bull trout may remain in freshwater for two to three years (or longer) before migrating to the ocean. Eighteen different populations of bull trout have been identified on the Olympic Peninsula, however little information exists on the presence or absence of bull trout in the Goldsborough Creek drainage (Spalding 1997). No bull trout were captured in a screw trap operated in Goldsborough Creek near RM 0.3 in 2000 (Celedonia et al. 2000).

Bull trout within the Puget Sound ESU were listed as threatened under ESA (64 *Fed. Regist*. 58911:58932) due to several detrimental factors (including disease, predation, increased stream temperatures, and loss of habitat). Likewise, Dolly Varden were proposed as threatened under ESA due to their similarity of appearance to bull trout (66 *Fed. Regist*. 1628:1632).

2.5 STEELHEAD

Steelhead, displaying perhaps the most diverse life history pattern of all Pacific salmonids, reside in most Puget Sound streams. Their historic native distribution extended from northern Mexico to the Alaska Peninsula. Presently, spawning steelhead are found along the Pacific Coast from as far south as Malibu Creek, California (Busby et al. 1996). Two different genetic groups (coastal and inland) of steelhead are recognized in North America (Busby et al. 1996). Both coastal and inland steelhead occur in British Columbia, Washington, and Oregon; while Idaho stocks are of the inland form and California steelhead stocks are all of the coastal variety (Busby et al. 1996). Within these groups, steelhead are further divided based on the state of sexual maturity when they enter freshwater. Stream-maturing steelhead (also called summer steelhead) enter freshwater in an immature life stage, while ocean maturing (or winter steelhead) enter freshwater with well-developed sexual organs (Busby et al. 1996). Goldsborough Creek steelhead (both summer and winter stocks) have been placed into the Puget Sound ESU, along with 53 other steelhead stocks, by the National Marine Fisheries Service (Busby et al. 1996). Total run size for the major stocks of this ESU was estimated at 45,000; natural escapement was estimated at 22,000 steelhead (Busby et al. 1996).

Winter and summer steelhead runs in Washington are differentiated by the timing of adult returns to freshwater. Adult steelhead entering Goldsborough Creek from November through May are considered winter steelhead (WDFW et al. 1994). Winter steelhead are native to Hammersley Inlet tributaries and spawn from February through early April (WDFW et al. 1994). Escapement of steelhead on Goldsborough Creek is not monitored by WDFW. Historically, Goldsborough Creek has received hatchery steelhead plants, however, WDFW considers any steelhead occurring in Goldsborough Creek a native stock sustained by natural production (WDFW 1994). Juvenile steelhead (n = 53; mean FL = 162) were captured in a screw trap operated in Goldsborough Creek near RM 0.3 in 2000 (Celedonia et al. 2000).

Goldsborough Creek steelhead have been classified as part of the Puget Sound ESU (1 of 15 west coast steelhead ESUs). National Marine Fisheries Service indicated that, in general, the entire Puget Sound ESU is not threatened at this time. Future population declines, however, may warrant changes in ESA status (Busby et al. 1996).

2.6 COASTAL CUTTHROAT TROUT

Coastal, or anadromous cutthroat trout, are distributed on the Pacific Coast from Prince William Sound in southern Alaska to the Eel River in northern California, rarely penetrating more than 100 miles inland (Johnston 1982; Behnke 1992). Considerable information exists for Puget Sound cutthroat trout, though little of that has been collected in a standardized manner and over a long enough time period to establish trends in populations (Leider 1997).

Coastal cutthroat trout exhibit early life history characteristics similar to coho and steelhead whereby juveniles spend time rearing in freshwater before outmigrating as smolts (Leider 1997). While little information exists on Goldsborough Creek cutthroat, Puget Sound cutthroat emigrate to estuaries at a younger age (age II) and smaller size (6 inches TL) than cutthroat that are exposed to rough coastal waters (age III to V, 8-10 inches TL) (Johnston 1982). Puget Sound cutthroat trout will feed and migrate along beaches, often in waters less than 10 feet deep (Johnston 1982). Many stocks are thought to stay within estuarine habitats for their entire marine life (Leider 1997). Most cutthroat return to freshwater the same year they migrate to sea. Juvenile cutthroat trout (n = 222; mean FL = 155 mm) were captured in a screw trap operated in Goldsborough Creek near RM 0.3 in 2000 (Celedonia et al. 2000).

Goldsborough Creek coastal cutthroat trout have been classified as part of the Puget Sound ESU by the National Marine Fisheries Service (64 *Fed. Regist.* 16397). This ESU includes populations of coastal cutthroat trout from streams in Puget Sound and the Strait of San Juan de Fuca west to, and including, the Elwha River. The southern boundaries of the Puget Sound ESU extend to Nisqually River, while the northern boundaries include coastal cutthroat trout populations in Canada (64 *Fed. Regist.* 16397). The Puget Sound coastal cutthroat trout does not warrant listing under ESA at this time; populations have been relatively stable over the past 10-15 years (64 *Fed. Regist.* 16397).

2.7 RESIDENT FISH

Little information about resident fish is available for Goldsborough Creek. Mongillo and Hallock (1997) examined the distribution and habitat of native nongame stream fishes on the Olympic Peninsula, including the Goldsborough Creek drainage. They concluded that eight nongame fish could potentially inhabit Goldsborough Creek. These fish include the speckled dace (*Rhinichthys osculus*), coastrange sculpin (*Cottus asper*), prickly sculpin (*Cottus perplexus*), reticulate sculpin (*Cottus gulosus*), riffle sculpin (*Cottus gulosus*), Pacific lamprey (*Lampetra tridentata*), three-spine stickleback (*Gasterosteus aculeatus*), and Olympic mudminnow (*Novumbra hubbsi*). Bernard (1999) also captured eulachon (*Thaleichthys pacificus*) in the Goldsborough Creek basin.

3. METHODS

3.1 SPAWNING SURVEYS

Spawning surveys were conducted from 28 August 2002 through 5 February 2003 on Goldsborough Creek. Surveys were scheduled once every two weeks during the study period. Five study reaches were surveyed based upon Missildine et al. (1999) and Jeanes and Hilgert (2000). The following index reaches in Goldsborough Creek basin were surveyed during the 2002 spawning season:

- Lower Goldsborough Creek – through and downstream of the Project Area (RM 0.5-2.2);
- Middle Goldsborough Creek – immediately upstream of the Project Area (RM 2.3-3.4);
- Upper Goldsborough Creek – upstream of the Project Area, near Carmen Rd. (RM 5.8-6.7);
- South Fork Goldsborough Creek (RM 9.9-11.0); and
- Coffee Creek (RM 0.0-0.3).

Spawning surveys were conducted by a single observer walking upstream, beginning at the lower site boundary, and proceeding to the end of the survey reach. Newly constructed redds were marked with survey flagging tied to rocks and placed adjacent to observed redds. Subsequent survey weeks utilized flagging of a different color. Total spawner counts on a survey represented all live fish observed and those dead fish not previously counted. Dead fish were marked on each survey by removing the entire caudal fin.

Water temperature (to the nearest 0.5°C) and stage (to the nearest (0.01 ft) were recorded on each survey date using a handheld thermometer and staff gage measurements, respectively. In addition, an Optic StowAway® temperature monitor from the Onset Computer Corporation was used to record hourly instream temperatures at the gage location just upstream from the Highway 101 bridge crossing. Stream discharge measurements were also collected at the stream gage location using a Swoffer Model 2100 velocity meter coinciding with spawner survey days. Representative photographs were taken of individual redds and index reaches.

Five snorkel surveys were also performed through the weir section (Project Area) of Goldsborough Creek to assess fish access throughout the Project Area. Two experienced snorkelers surveyed upstream through each weir and enumerated all salmonids observed. Dive lights were used as needed to assist visibility. An additional observer/recorder was present on the bank during snorkel surveys. All data were transcribed onto field data sheets, entered electronically using MS Excel, and cross-referenced with original field data forms for QA/QC purposes.

3.2 MACROINVERTEBRATE FIELD METHODS

Sampling methods generally followed the Washington Department of Ecology's (Ecology) protocols for benthic macroinvertebrates (Plotnikoff 1994). In October and again in February four samples were collected from each of four survey locations using a D-frame kick-net sampler fitted with 500-micron Nitex mesh. Site locations were selected in an effort to match previous invertebrate sampling performed by the U.S. Fish and Wildlife Service in October 1998 (Missildine et al. 1999). Site 1 is located downstream of the Project Area near the stream gage site. Sites 2 and 3 are within the Project Area, while Site 4 is upstream of the Project Area. All samples were collected in riffles or shallow runs possessing a substrate consisting of coarse gravel to small cobble. All samples were collected from water depths of approximately 0.5 to 1.0 feet, and mean water column velocities between approximately 1.0 and 3.0 ft per second. Sample locations were randomly selected, although sampling was not conducted at a specific location unless depths and water velocities were within the suitable range specified above. Depths were measured with a top-setting rod and velocities were measured with a Swoffer Model 2100 velocity meter.

Each sample was collected from an area of the stream bottom 1 ft wide (the width of the kick net) and 2 ft long (i.e., 0.19m^2). The stream bottom was vigorously disturbed for a period of one minute. Large substrates were scrubbed by hand to dislodge remaining organisms. Substrates were sampled to a depth of approximately 0.2 ft (6.0 cm). The contents of the kick net were transferred into a large tub and the net was backflushed several times with river water to dislodge as many organisms as possible while the rinsate collected in the tub. The contents of the tub were poured through a 500-micron mesh sieve. After rinsing, swirling, and pouring the contents of the tub through the sieve three times, the heavier particles remaining in the bucket were examined and macroinvertebrates noted and removed (e.g., crayfish). The contents of the sieve were then emptied into a 16-oz, wide-mouth glass Mason jar with a rubber spatula. The sieve was subsequently rinsed with 86 percent ethyl alcohol and the rinsate was collected in the Mason jar. Any invertebrates still clinging to the kick net mesh were removed with fine point forceps or by hand and placed into the Mason jar. The depth, mean column velocity, substrate composition, and water temperature of each sampling location were transcribed onto field data sheets, entered electronically using MS Excel, and cross-referenced with original field data forms for QA/QC purposes.

3.3 MACROINVERTEBRATE LABORATORY METHODS

Following field collection the samples were transported to Aquatic Biology Associates, Inc. for processing. The four subsamples were consolidated in a white plastic tray. Large debris was rinsed and removed. The sample was then elutriated until all organic matter and invertebrates were separated from the mineral residue and collected on a 500 micron sieve. The mineral residue remaining in the white pan after elutriation was searched for remaining stone-cased caddisflies and molluscs.

A Caton Tray was used to randomly obtain 500-600 organisms from the total sample. Subsample data was then converted to a full sample basis based on this fraction. Experienced technicians were used to remove all invertebrates from the sample fraction using dissecting scopes at 6X or 12X power. All invertebrates removed were placed in a single sorting vial and given directly to Robert W. Wisseman, Senior Scientist of Aquatic Biology Associates, Inc. for expert identification.

The entire sample residue was saved after sorting to check for sorting efficacy. Sorting efficiency of 95% or better was required on all samples. A 20% aliquot of each residue was thoroughly re-sorted to determine efficacy. The entire residue was re-sorted if 95% or better sorting efficacy had not been achieved, as estimated from the 20% aliquot re-sort. Identifications and counts were recorded on bench-sheets and then transferred to electronic files. The use of standardized bench-sheets reduced data entry errors. Aquatic Biology Associates, Inc. used standard methods outlined by Kleindl (1995) to calculate a benthic invertebrate index of biological integrity and other metrics described below.

Following taxonomic identification and enumeration of each sample, the abundance of each taxonomic group was used to calculate the key biotic metrics. The following are some of the more important metrics and biotic indices that were calculated for each invertebrate sample.

Density – Density is calculated as the number of individuals per unit area (i.e., m^2). Density values could be estimated from the samples because they were collected from a standardized sample area (0.19 m^2).

Taxa Richness – Taxa richness is the total number of unique macroinvertebrate taxa present in the combined samples. This metric generally increases with enhanced water quality and/or habitat diversity, and it is used as a relative measurement of the health of the benthic invertebrate community.

Mayfly, Stonefly, and Caddisfly (EPT) Taxa Richness – This metric describes the number of distinct taxa within the insect orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies). These insect orders are relatively sensitive to habitat disturbance or water quality degradation and are important items in fish diets. Taxa richness values were also calculated separately for mayflies, stoneflies, and caddisflies because certain human disturbances can decrease the diversity of one order and not the others. The separate taxa richness values generally increase with improving water quality. Consequently, these indicators are widely used for overall stream health.

Intolerant Taxa Richness – Intolerant taxa are known to be sensitive to stream disturbance. For this report, intolerant taxa are defined as sensitive species present in water of sufficient quality (i.e., temperature, oxygenation) to support salmonid rearing.

Long-Lived Taxa Richness – Long-lived taxa are organisms that complete their immature life cycle in more than one year. Because they are long-lived, they are not expected to survive single, catastrophic events that occur infrequently (every one or more years) or to more regular, subtle disturbances that repeatedly interrupt their life cycle. Their presence in a stream suggests a lack of such disturbances. Representative long-lived species include certain mayfly and stonefly species as well as many snails, mussels, and riffle beetles.

Percent Planaria and Amphipoda – Planaria are a type of flatworm that whose presence is indicative of poor water quality conditions. The presence of Amphipoda (scuds) also usually signifies poor water quality conditions.

Percent Tolerant Taxa – Percent tolerant taxa is the relative abundance of all invertebrates in a sample are tolerant to disturbance. For the purposes of this study, tolerant taxa were defined as taxa that are present in unshaded, warm nutrient-enriched streams.

Percent Predator Taxa – Predators feed on living animal tissues or prey. They are the top of the macroinvertebrate food chain and rely on a steady source of other invertebrates or animal tissue for food. Less disturbed sites support a greater diversity of prey items, and thus a higher percentage of predators.

Functional Feeding Group Classification – Each aquatic invertebrate taxon was placed in one of five functional feeding groups, to categorize the trophic status (i.e., food requirements) of the organism. The functional feeding group categories in our analysis were: 1) *grazers (or scrapers)*, which feed upon attached algae or periphyton; 2) *shredders*, which feed upon coarse particulate organic matter (CPOM) such as leaves; 3*) collectors*, which feed upon fine particulate organic matter (FPOM) deposits such as detritus; 4) *filter feeders*, which feed upon FPOM within the water column; and 5) *predators*. The functional feeding groups were determined by Robert W. Wisseman, Senior Scientist of Aquatic Biology Associates.

Modified Hilsenhoff Biotic Index – This index is used to portray the overall pollution tolerance of the benthic invertebrate community as a single value (Barbour et al. 1999). Tolerance values for individual organisms range from 1 to 10, with 1 describing very little or no tolerance to organic pollution and 10 describing high tolerance to organic pollution. The cumulative score for the benthic community results in a water quality and degree of organic pollution rating (Table 1). The Hilsenhoff Biotic Index (HBI) is calculated as:

$$HBI = \sum x_i t_i \ / \ n$$

where x_i is number of individuals within a given taxa, t_i is the tolerance value for this taxa, and n the total number of organisms in a sample. The HBI tolerance values for each invertebrate taxonomic group were obtained from Hilsenhoff (1987). The HBI was compared with values determined from samples collected by the Washington Department of Ecology in October 1998 in other local streams.

Table 1. Cumulative HBI scores and the corresponding evaluation of the degree of organic pollution.

Cumulative HBI Score	Degree of Organic Pollution
0.00 to 3.50	No apparent organic pollution
3.51 to 4.50	Possible slight organic pollution
4.51 to 5.50	Some organic pollution
5.51 to 6.50	Fairly significant organic pollution
6.51 to 7.50	Significant organic pollution
7.51 to 8.50	Very significant organic pollution
8.51 to 10.00	Severe organic pollution

Benthic Index of Biotic Integrity – The Benthic Index of Biotic Integrity (B-IBI) (Kleindl 1995) is a relatively new multi-metric index used to assess the biotic integrity of streams. The B-IBI is a modified version of the IBI that was first developed to assess fish communities in midwestern streams (Karr 1991). The modification involves the use of aquatic macroinvertebrates rather than fish to assess the biological health of a stream in relation to human and ecosystem disturbances (Table 2).

The B-IBI incorporates a number of metrics or attributes of the macroinvertebrate community that change in predictable ways in response to human disturbance. The metrics used in the calculation of the B-IBI were consistent with the metrics used by Ecology in their calculation of biotic integrity and included: 1) total taxa richness, 2) Ephemeroptera taxa richness, 3) Plecoptera taxa richness, 4) Trichoptera taxa richness, 5) intolerant taxa richness, 6) long-lived species taxa richness, 7) percentage of tolerant taxa, 8) percentage of predators, and 9) percentage of Planaria and Amphipoda. Each metric in the B-IBI is given a score to reflect the level of disturbance that is detected by the metric (5 for minimal, 3 for moderate, and 1 for severe disturbance).

Table 2. Metrics and scoring criteria for each metric in the Puget Sound B-IBI. (Adapted from Kleindl 1995).

Metric	**1 if …**	**3 if …**	**5 if …**
Taxa Richness	<10.0	10.0-20.0	>20.0
Ephemeroptera Richness	<3.0	3.0-5.5	>5.5
Plecoptera Richness	<3.0	3.0-6.0	>6.0
Trichoptera Richness	<2.0	2.0-4.5	>4.5
Intolerant Taxa Richness	<0.5	0.5-2.0	>2.0
Long-lived Taxa Richness	<0.5	0.5-2.0	>2.0
% Planaria and Amphipods Abundance	>20%	5%-20%	<5%
% Tolerant Taxa	>50%	20%-50%	<20%
% Predator Taxa	<15%	15%-30%	>30%

All metric scores are summed to calculate the total B-IBI value. B-IBI scores are as follows:

39 - 45 = excellent biological integrity;
32 - 38 = good biological integrity;
25 - 30 = fair biological integrity;
18 - 24 = poor biological integrity; and
09 - 18 = very poor biological integrity

Multi-metric indexes like the B-IBI are better at detecting disturbances than single metric indexes (e.g., presence or absence of indicator species) because they use a number of biological attributes that integrate information from ecosystem, community, population, and individual levels (Barbour et al. 1995).

4. RESULTS AND DISCUSSION

4.1 SALMONID SPAWNING

A total of thirteen spawning surveys were conducted from 28 August 2002 through 5 February 2003. Chinook, chum, coho salmon and cutthroat trout were the only species encountered during the surveys. Cutthroat trout observations were incidental and were not enumerated. The results of individual index reaches and discussion are presented in their respective sections below. In addition, snorkel surveys were performed in the Project Area approximately every two weeks from 4 September 2002 to 11 November 2002, for a total of 5 survey trips.

4.1.1 Lower Goldsborough Creek RM 0.5-2.2

The 2002 survey effort covered approximately 8,900 ft of stream in Goldsborough Creek beginning at the 7th street bridge in Shelton, proceeding upstream through the Project Area and ending at the upstream-most weir just above the railroad bridge (Figures 6 and 7).

A total of 278 live chum were observed in this survey reach (Table 3). The number of live chum salmon observed in Lower Goldsborough Creek peaked on 23 December (81 chum) (Figure 8; Table A-1). Low numbers of Chinook (N=7) were observed during the end of September and the beginning of October. Chum salmon were observed spawning in the weir section between weir groups 4 and 5 on 20 January 2003. Unlike year 2001 surveys, streamflows in this reach provided good visibility throughout the survey period with the exception of the weir pools. Turbulence caused by the weirs, and depth of the weir pools limited survey visibility within the Project Reach so snorkel surveys were performed in addition to foot surveys to accommodate for lack of visibility in this reach (see section 4.1.6)

4.1.2 Middle Goldsborough Creek RM 2.3-3.4

The 2002 survey effort covered approximately 5,280 ft of stream in Goldsborough Creek immediately upstream of the Project Area (Figures 9 and 10). 28 chum, 2 coho and no Chinook were observed upstream from the Project Area (Table A-2). Seven (7) chum redds, one coho redd, and no Chinook redds were observed in this reach.

Table 3. Summary of live salmon counts for five index reaches established in the Goldsborough Creek basin, 1999-2002. Data from R2 Resource Consultants and WDFW (escapement estimates in parentheses when available).

	1999	2000	2001	2002
Coffee Creek				
Chinook	0	0	0	0
Chum	31	20	291 (814)	188
Coho	0	33	2	1
Lower Goldsborough				
Chinook	2	22	10	7
Chum	119 (239)	174 (236)	71 (248)	278
Coho	0	96	2	4
Middle Goldsborough				
Chinook	0	0	1	0
Chum	0	0	35 (84)	28
Coho	0	5	4	2
Upper Goldsborough				
Chinook	0	0	0	0
Chum	0	0	0	0
Coho	0	0	0	0
S. Fork Goldsborough				
Chinook	0	0	0	0
Chum	0	0	0	0
Coho	0	0	10	0
Totals				
Chinook	*2*	*22*	*11*	*7*
Chum	*150*	*194*	*397*	*494*
Coho	*0*	*134*	*18*	*7*

4.1.3 Upper Goldsborough Creek RM 5.8-6.7

The 2002 survey effort covered approximately 5,280 ft of stream in Goldsborough Creek immediately upstream and downstream of the Matlock Road Bridge (near Carmen Road) during ten surveys (Figures 11 and 12). As in the past three survey years, no adult salmonids or redds were observed during the 2002 study period in this survey reach (Table A-3). One adult cutthroat trout and an unoccupied redd were observed on 30 January 2003.

4.1.4 South Fork Goldsborough Creek RM 9.9-11.0

The 2002 survey effort covered approximately 5,800 ft of stream in the South Fork Goldsborough Creek (Figures 13 and 14). No adult fish or redds were observed in the South Fork Goldsborough Creek during the 2002 study period (Table A-4). Ten (10) adult coho were observed in this section during the 2001 survey year (Table 3).

4.1.5 Coffee Creek RM 0.0-0.3

The 2002 survey effort covered approximately 1,580 ft of stream in Coffee Creek (Figures 15 and 16). During the 2002 survey effort, 1 live coho, and no coho redds were observed in Coffee Creek (Table A-5). A total of 188 live chum were observed in Coffee Creek (Figure 17). A total of 46 chum redds were observed in Coffee Creek during the 2002 survey effort (Table 3).

4.1.6 Snorkel Surveys

Snorkel surveys were performed on 4 September, 30 September, 14 October, 28 October and 11 November 2002. Numerous cutthroat and rainbow trout (N=2,981) and juvenile coho (n=220) were observed during snorkel surveys, however, only three adult chum and one adult coho were observed (Table 4). One chum was observed on 14 October 2002, and one chum and one coho were seen on 28 October 2002.

4.1.7 Temperature and Discharge Monitoring Results

An Onset Optic StowAway® temperature monitor was installed in the mainstem of Goldsborough Creek near the stream gage site just upstream from the Highway 101 bridge crossing. Water temperature ranged from a low of approximately 3°C on 2 November 2002 to a high of 20°C on 22 July 2003 (Figure 18). The discharge measurements allowed for a crude stream discharge/stage curve to be developed for the Goldsborough Creek gage site (Figure 19). Overall, measured discharge ranged from 24.3 cubic feet per second (cfs) in late September to 150.6 cfs in early January 2003.

Table 4. Combined snorkel survey salmonid counts conducted in the Project Reach of Goldsborough Creek, 2002. Weirs were enumerated in a downstream to upstream order (i.e., 1-1 downstream-most and 7-5 is upstream-most weir).

WEIR	1-1	1-2	1-3	1-4	1-5	1-6	2-1	2-2	2-3	2-4	2-5
Trout <6"			33	69	54	64	74	69	93	85	55
Juvenile coho			4	3	3	4	3		8	6	2
Trout >6"			9	22	13	9	11	14	6	8	7
Adult chum											
Adult coho											
Totals	*0*	*0*	*46*	*94*	*70*	*77*	*88*	*83*	*107*	*99*	*64*

WEIR	3-1	3-2	3-3	3-4	3-5		4-1	4-2	4-3	4-4	4-5
Trout <6"	80	77	54	66	69		96	72	55	51	62
Juvenile coho	6		9	10	8		25	4		4	1
Trout >6"	11	13	12	8	9		16	11	13	7	12
Adult chum				1							1
Adult coho											
Totals	*97*	*90*	*75*	*85*	*86*		*137*	*87*	*68*	*62*	*76*

WEIR	5-1	5-2	5-3	5-4	5-5		6-1	6-2	6-3	6-4	6-5
Trout <6"	106	58	70	85	58		97	55	86	93	89
Juvenile coho	12	4	2	16	14		7	16	4	2	4
Trout >6"	30	5	23	12	24		20	5	13	13	10
Adult chum	1										
Adult coho					1						
Totals	*149*	*67*	*95*	*113*	*97*		*124*	*76*	*103*	*108*	*103*

WEIR	7-1	7-2	7-3	7-4	7-5	Grand Total
Trout <6"	74	106	69	100	94	2518
Juvenile coho	14	4		8	13	220
Trout >6"	17	14	12	27	27	463
Adult chum						3
Adult coho						1
Totals	*105*	*124*	*81*	*135*	*134*	*3,205*

4.1.8 Summary

While estimated chum escapement was again higher than in recent survey years, overall, chum escapement is still in a period of decline in Goldsborough Creek. From 1994 through 1998, escapement to the Goldsborough Creek through and downstream of the Project Area averaged 1,714 chum (std. Deviation = 1,261) (Figure 20; Table A-6).

These study results indicate that there is continued post-dam removal salmonid passage above the Project Area. However, fewer salmon were observed above the Project Area than in 2001. Also, compared to 2001 survey results, more chum salmon were observed in the lower Goldsborough survey section, and fewer in Coffee Creek. It appears that during Project construction conducted in 2001, more chum utilized Coffee Creek out of necessity (inability to pass through the Project Area). The largest concentration of chum redds was recorded immediately below the Project Area. In conjunction with other trends, it may appear as though chum salmon are not passing throughout the Project Area. Snorkel surveys did not indicate large numbers of chum residing within the weir sections, however. In past seasons, chum have been relegated to the lower sections in Goldsborough Creek and may presently be in an exploratory mode in Goldsborough Creek. Overall, low numbers of adult salmon returning to Goldsborough Creek are complicating pre- and post-dam removal monitoring efforts. Like chum, coho salmon numbers observed in Goldsborough Creek were depressed in 2002. Only one (1) coho was observed in Coffee Creek in 2002, while six (6) were observed in the mainstem of Goldsborough Creek. Adult coho were not observed in South Fork Goldsborough Creek (Figure 21).

Future monitoring efforts will continue to examine the passage of adult salmon through the Project Area. Preliminary monitoring efforts indicate that adult salmon are passing through the lower reaches of Goldsborough Creek to access areas that were formerly blocked by the dam. Pre-dam removal surveys did not indicate that chum salmon were using stream reaches located upstream of the dam. Initial post-dam removal surveys have observed chum salmon spawning in these stream reaches and will help document the success of the innovative salmon enhancement/restoration project constructed by the USACE in Goldsborough Creek.

Figure 6. Upstream end of Lower Goldsborough Creek index reach located downstream of the Project Area (RM 0.5-2.2).

Figure 7. Downstream end of Lower Goldsborough Creek index reach located downstream of the Project Area (RM 0.5-2.2).

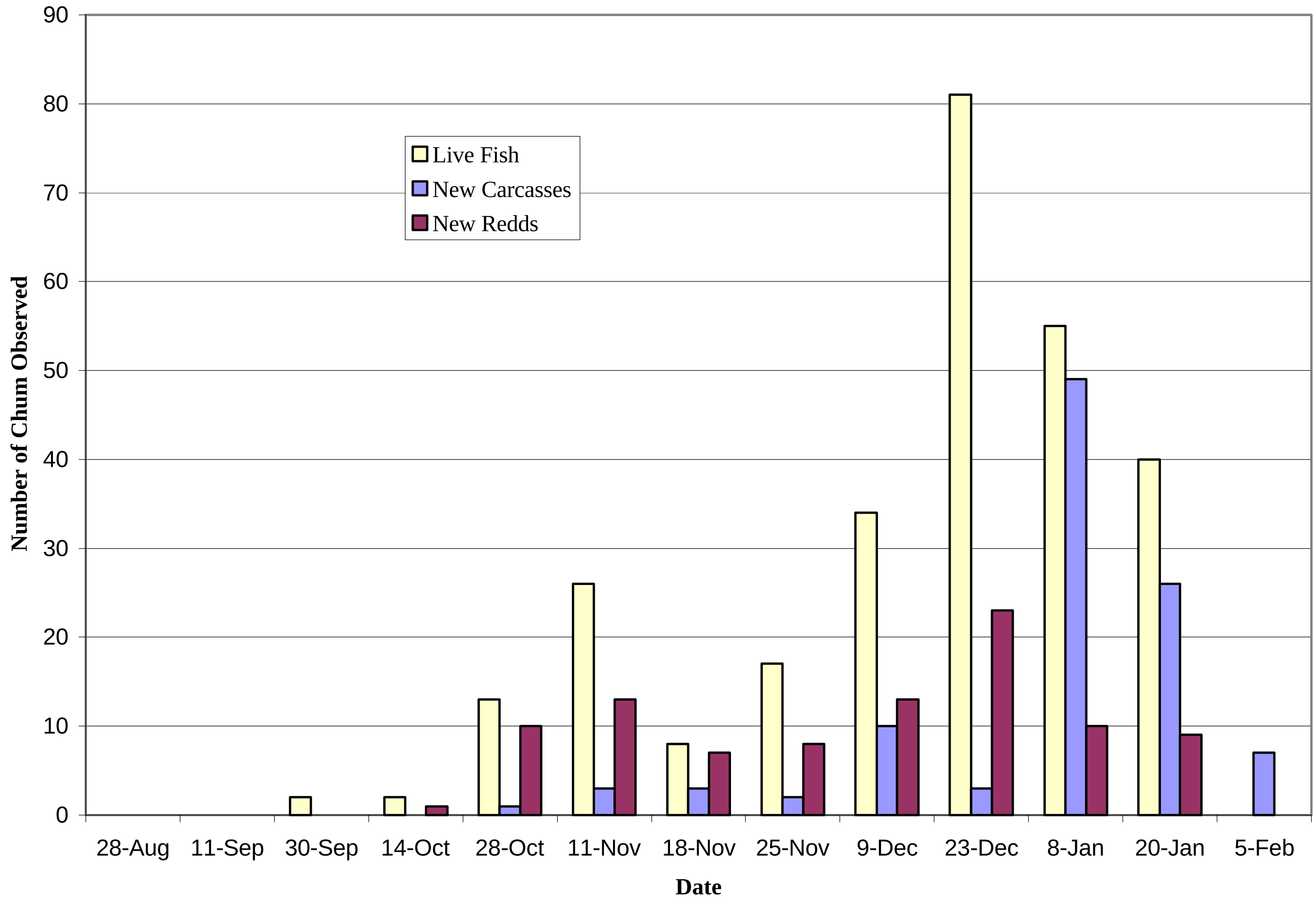


Figure 8. Number of live chum, chum carcasses, and new chum redds observed during spawning surveys conducted in Lower Goldsborough Creek index reach (RM 0.5-2.2), 2002.

Figure 9. Upstream end of Middle Goldsborough Creek index reach located upstream of Project Area (RM 2.4-3.4).

Figure 10. Downstream end of Middle Goldsborough Creek index reach located upstream from Project Area (RM 2.4-3.4).

Figure 11. Upstream end of Upper Goldsborough Creek index reach (RM 5.8-6.7).

Figure 12. Downstream end of Upper Goldsborough Creek index reach (RM 5.8-6.7).

Figure 13. Upstream end of South Fork Goldsborough Creek index reach (RM 9.9-11.0).

Figure 14. Downstream end of South Fork Goldsborough Creek index reach (RM 9.9-11.0).

Figure 15. Upstream end of Coffee Creek index reach (RM 0.0-0.3).

Figure 16. Downstream end of Coffee Creek index reach (RM 0.0-0.3).

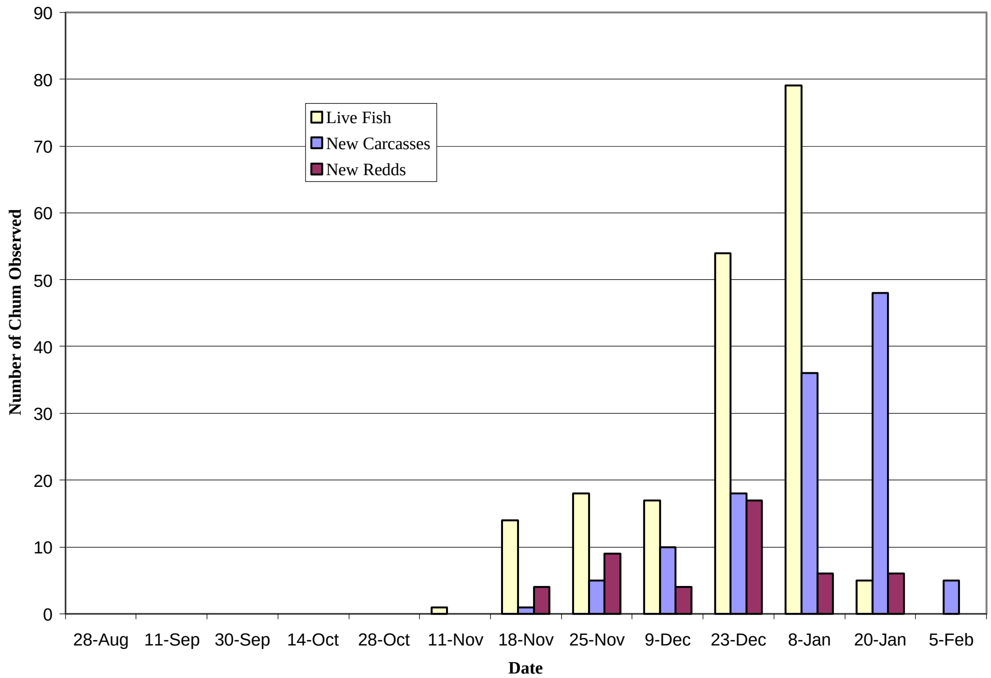


Figure 17. Number of live chum, chum carcasses, and new chum redds observed during spawning surveys conducted in Coffee Creek (RM 0.0-0.3), 2002.

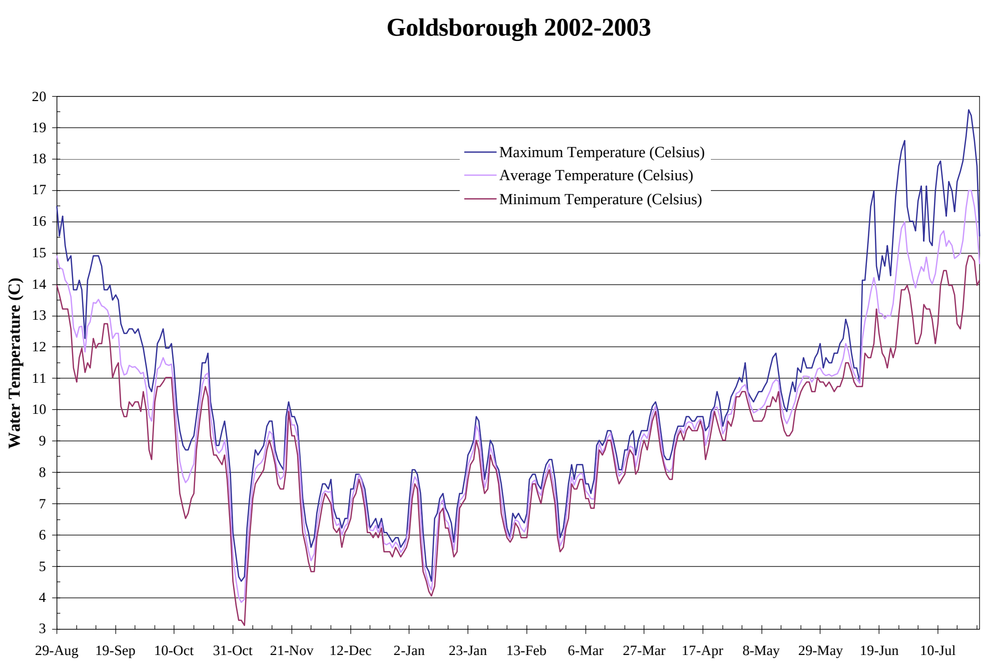
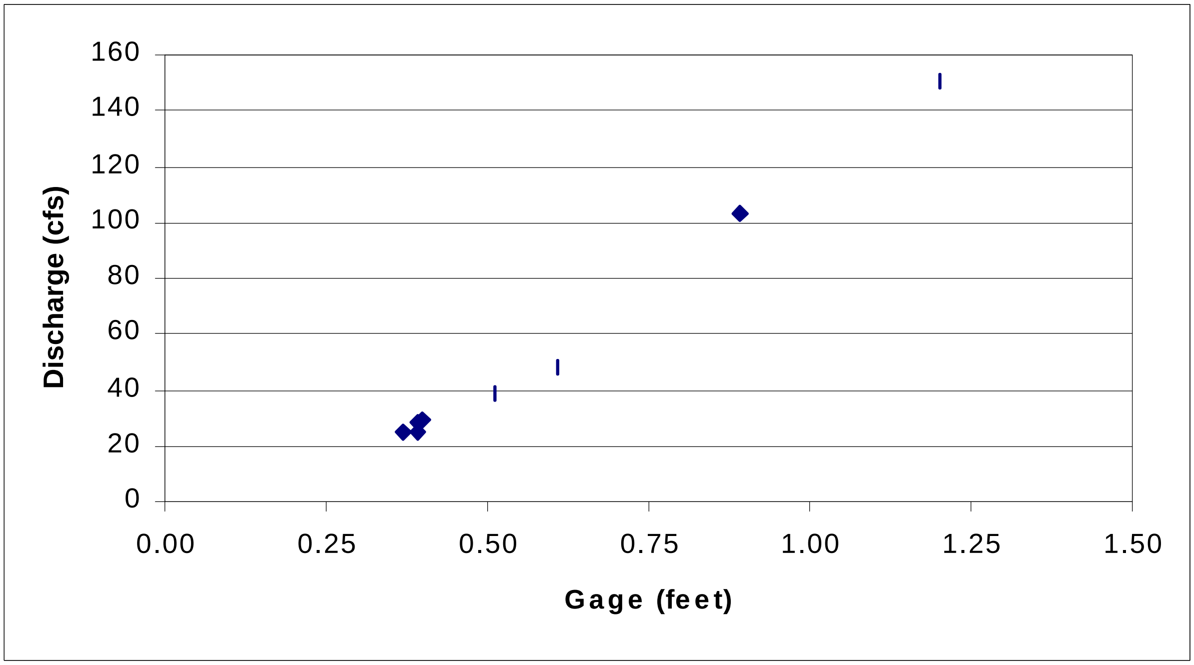


Figure 18. Minimum, average and maximum stream temperature in Goldsborough Creek, Washington.



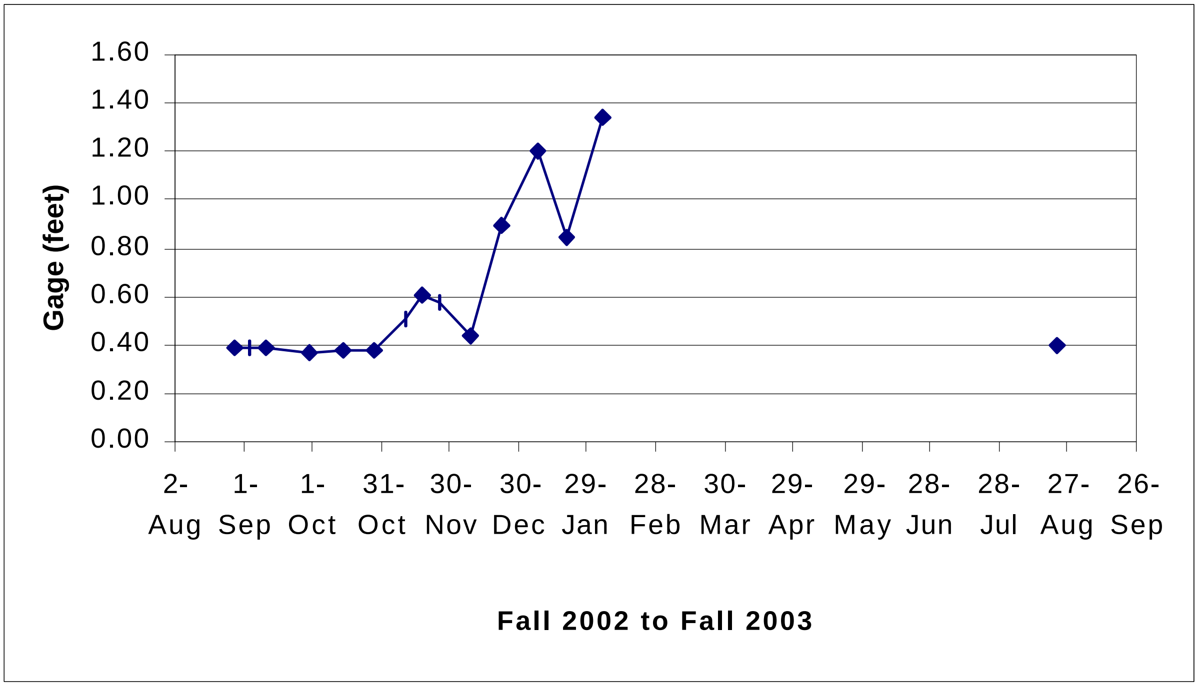


Figure 19. Stream gage/discharge relationship developed for Goldsborough Creek, Washington.

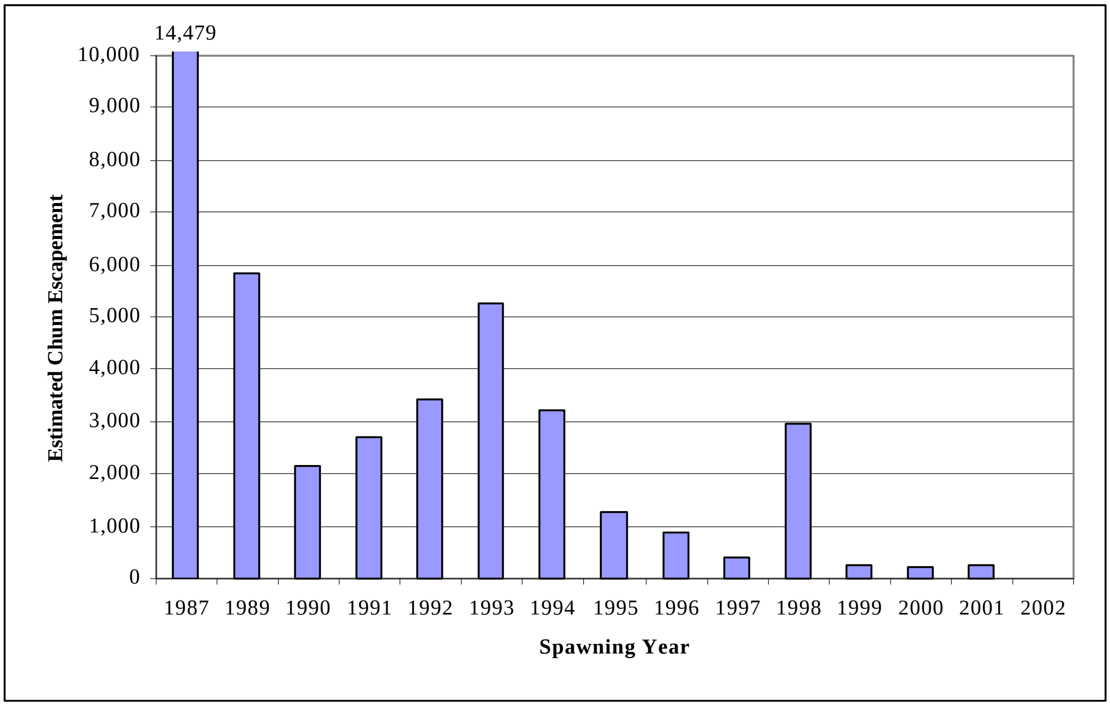


Figure 20. Estimated chum salmon escapement to Goldsborough Creek basin, Washington (RM 0.5-2.2), 1987-2002 (adapted from Seavey 1999).

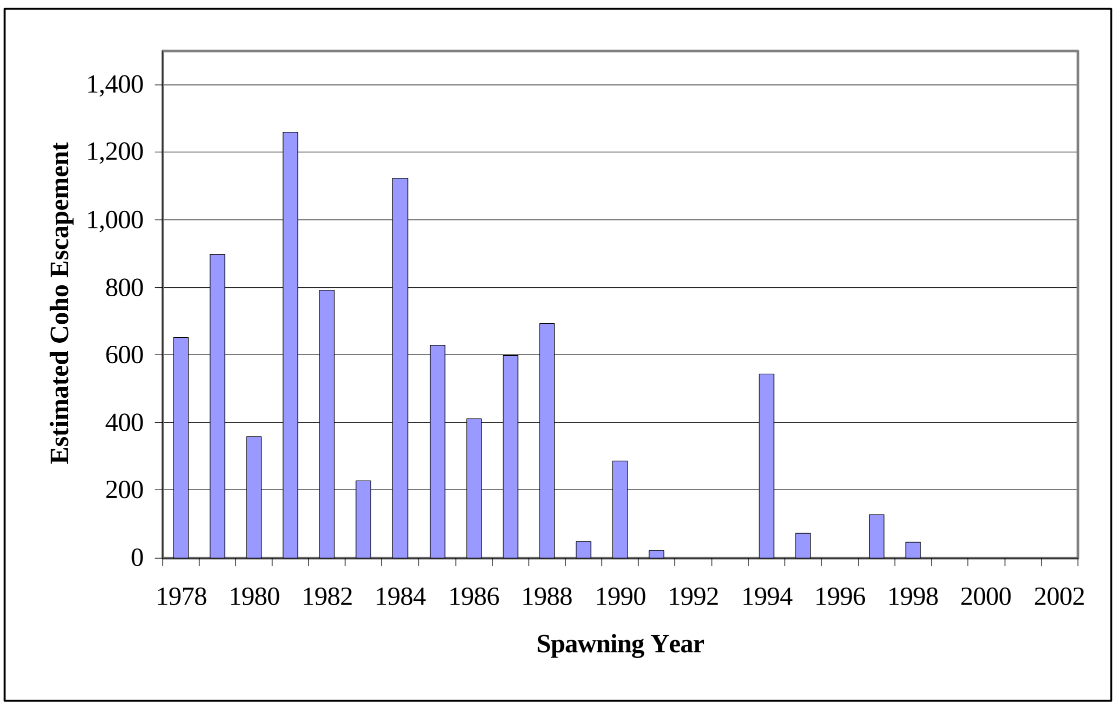


Figure 21. Estimated coho salmon escapement to the South Fork Goldsborough Creek, Washington (RM 9.9-11.0), 1978-2002 (adapted from Seavey 1999).

4.2 MACROINVERTEBRATE RESULTS AND DISCUSSION

The following macroinvertebrate data results are discussed primarily in terms of the metrics used to calculate the B-IBI score. The results are provided for the fall 2002 and winter 2003 samples and for the fall 1998 samples collected by the USFWS before the dam was removed (Table 5).

Density – Total macroinvertebrate abundance was much higher for the fall samples (average = 18,140 m^2) than the winter samples (average = 3,432m^2). The highest density was recorded at Site 3 in the fall, the lowest at Site 1 in the winter. Although there is a relatively wide range in average densities, these values are within the range indicative of a healthy system. High macroinvertebrate densities do not necessarily indicate a healthy stream. Conversely, high density coupled with low diversity could indicate disturbed conditions. Similarly, low macroinvertebrate densities have been measured in pristine habitats with excellent water quality. Densities for the 1998 USFWS samples are not available for comparison.

Taxa Richness – Taxa richness is generally considered to be one of the most useful metrics to describe biological integrity in streams. The total number of macroinvertebrate taxa in a stream reflects the diversity of the benthic community and is typically directly related to stream health. Taxa richness in Goldsborough Creek ranged from a low of 37 to a high of 47 in the fall and a low of 48 to a high of 59 in the winter. For these samples, the total number of taxa (species diversity) was rated 5 for all samples in both seasons (see Table 2 for a description of rankings). USFWS results from October 1998 indicate a rating of 5 as well (Missildine et al. 1999).

Mayfly, Stonefly, and Caddisfly (EPT) Taxa Richness – The number of mayfly (Ephemeroptera), stonefly (Plecoptera) and caddisfly (Trichoptera) (EPT) species present in a stream is typically positively correlated to the water quality and negatively to habitat disturbance. EPT taxa richness ranged from 18 to 25 in the fall samples and from 26 to 31 in the winter samples.

Taxa richness of the individual orders were all relatively high and were ranked as 5 except for one sample (Site 3 fall) where the Ephemeroptera taxa richness was ranked 3. The number of Ephemeroptera taxa has increased and is an improvement over the pre-dam sampling results in which 6 samples received a ranking of 5, and 3 samples a ranking of 3 (Missildine et al. 1999).

Intolerant Taxa Richness – Intolerant taxa are those most sensitive to water quality degradation or habitat disturbances. The presence of intolerant taxa indicates good water quality and natural, undisturbed habitat. The winter sample for Site 2 had the highest number of intolerant taxa (2.4); the fall Site 1 had the lowest measuring 0.2. The winter sample metrics were rated 5, and the fall samples were rated 3. USFWS 1998 samples consisted of 2 moderate rankings at sites 1 and 2, and a metric ranking of 1 at Site 3 (R2 site 4) (Missildine et al. 1999).

Long-Lived Taxa Richness – The number of long-lived taxa ranged from 1 to 2 for the fall samples, and from 3 to 5 for the winter samples. The fall samples have a metric rank of 3, and the winter samples have a rank of 5. The USFWS scores from 1998 for this metric were 3 for the site below the Project Area and 1 for the sites within and above the Project Area (Missildine et al. 1999).

Percent Planaria and Amphipoda – No Planaria or Amphipoda species were found in any samples. The lack of these species indicates good water quality conditions and ranks 5 on the B-IBI metric scoring table (see Table 2). The USFWS data from 1998 also indicate low Planaria and Amphipoda abundance (Missildine et al. 1999). Although the USFWS metric scoring in Missildine et al. (1999) indicates low Planaria and Amphipoda abundance rates (metric score = 1), we have adjusted this ranking to a 5 based on the ranking criteria currently used (see Table 5).

Table 5. B-IBI scores for the four Goldsborough Creek sites at three different sampling periods respectively: October 1998 / October 2002 / February 2003 (current metric scores are in parenthesis).

R2 Site	**1**	**2**	**3**	**4**
USFWS Site	**1**	**-**	**2**	**3**
Taxa Richness	5 / 5 / 5	- / 5 / 5	5 / 5 / 5	5 / 5 / 5
Ephemeroptera Richness	5 / 5 / 5	- / 5 / 5	3 / 3 / 5	3 / 5 / 5
Plecoptera Richness	5 / 5 / 5	- / 5 / 5	3 / 5 / 5	5 / 5 / 5
Trichoptera Richness	5 / 5 / 5	- / 5 / 5	5 / 5 / 5	5 / 5 / 5
Intolerant Taxa Richness	3 / 3 / 5	- / 3 / 5	3 / 3 / 5	1 / 3 / 5
Long-lived Taxa Richness	3 / 3 / 5	- / 3 / 5	1 / 3 / 5	1 / 3 / 5
% Planaria and Amphipods Abundance	1(5) / 5 / 5	- / 5 / 5	1(5) / 5 / 5	1(5) / 5 / 5
% Tolerant Taxa	5 / 3 / 5	- / 3 / 3	5 / 5 / 5	5 / 5 / 5
% Predator Taxa	3 / 1 / 1	- / 1 / 1	3 / 1 / 1	3 / 1 / 1

Percent Tolerant Taxa – Percent tolerant taxa ranged from 18.0 to 30.8% for the fall samples, and 10.3 to 21.5% for the winter samples. In both sampling periods, Site 2 had the highest percentage of tolerant taxa (Site 2 is the downstream-most sample site located within the weirs). A higher percentage of tolerant taxa present can be indicative of the disturbed habitat of the weirs, however tolerant taxa can be present under undisturbed as well as disturbed conditions. The USFWS data from 1998 for percent tolerant taxa rated 5 at all sites (Missildine et al. 1999).

Percent Predator Taxa – Percent predator taxa ranges from 2.3 to 7.2% in the fall samples and from 6.1 to 13.3% for the winter samples. All of these percentages have a metric rank of 1 (I.e., anything less than 15%) (see Table 2). Although all of the sites had relatively few predators, the upstream most site (Site 4) had the highest percentage of predators of the surveyed sites. The USFWS 1998 samples for percent predators all ranked 3 on the B-IBI metric scale. The decreased percentage of predator taxa may be a result of the disturbed nature of the Project Area.

Functional Feeding Group Classification – Overall, collector/gatherers and collector/filterers were the most common functional feeding group for all sites sampled at both seasons. The dominance of collectors suggests an abundance of fine particulate organic matter. This particulate organic matter is usually contributed to the system through riparian vegetation, and is maintain in the channel through channel complexity. No information concerning functional feeding groups is available for comparison from the 1998 USFWS samples.

Modified Hilsenhoff Biotic Index – Modified Hilsenhoff Biotic Index scores for all sites in both sampling seasons were below 4.5, ranking as either “no apparent organic pollution,” or “possible slight organic pollution.” This metric was not analyzed for the USFWS 1998 samples.

Benthic Index of Biotic Integrity – The B-IBI scores ranged from 35 to 37 for the fall samples and from 39 to 41 for the winter samples (Table 6). The scores for the winter samples are within the range that is considered “excellent” for the index (see section 3.4). The fall scores are within the “good” category. These scores are slightly higher than those for samples collected by the USFWS in October of 1998 prior to dam removal (Table 3). However, if the final USFWS B-IBI scores were increased to adjust for the lack of Planaria and Amphipoda, totals would be more similar to those obtained from the 2002/2003 samples.

Table 6. B-IBI scores and ranking for four Goldsborough Creek sample sites (see Appendix Tables A-7 and A-8 for complete B-IBI information).

	R2 Site 1 / USFWS Site 1	**R2 Site 2 / No USFWS**	**R2 Site 3 / USFWS Site 2**	**R2 Site 4 / USFWS Site 3**
1998 fall	35 (good)	-	29 (fair)	29 (fair)
1998 fall (adjusted)	39 (excellent)	-	33 (good)	33 (good)
2002 fall	35 (good)	35 (good)	35 (good)	37 (good)
2002 winter	41 (excellent)	39 (excellent)	41 (excellent)	41 (excellent)

Conclusions – Salmon are dependant on a freshwater habitat that is healthy and diverse to survive. Benthic macroinvertebrates are an indicator of a stream's overall biological condition. High B-IBI scores, as obtained from four sites, are indicative of healthy salmon habitat in the study reach of Goldsborough Creek. Low water temperatures, low quantities of fine sediments, relatively stable substrates and sources of detrital food sources (riparian vegetation) are key factors that support a healthy macroinvertebrate community. These same factors can result in habitat that supports salmonids. Overall the results imply the Project Area of Goldsborough Creek has good water quality and benthic invertebrate habitat conditions.

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APPENDIX A

Raw Data

Biological Monitoring
Goldsborough Creek, Washington
2002 Spawning and
Macroinvertebrate Surveys
Data Report

Table A-1. Date, species, number of live and dead salmon, and number of new redds observed, water temperature (°C), and stage observed in Lower Goldsborough Creek, Washington, (RM 0.5-2.2), 2002.

Date	Species	Live	Dead	Redds	Water Temp. (°C)	Stage (ft)
28-Aug-02	chum	0	0	0	15.0	0.39
11-Sep-02	chum	0	0	0	13.0	0.39
30-Sep-02	chinook	2	0	2	11.0	0.37
30-Sep-02	chum	2	0	0	11.0	0.37
14-Oct-02	coho	1	1	1	7.0	0.38
14-Oct-02	chum	2	0	1	7.0	0.38
14-Oct-02	chinook	5	1	4	7.0	0.38
28-Oct-02	coho	2	0	0	9.0	0.38
28-Oct-02	chum	13	1	10	9.0	0.38
11-Nov-02	chum	26	3	13	9.0	0.51
18-Nov-02	coho	1	0	2	8.0	0.61
18-Nov-02	chum	8	3	7	8.0	0.61
25-Nov-02	chum	17	2	8	7.0	0.58
9-Dec-02	chum	34	10	13	5.5	0.44
23-Dec-02	chum	81	3	23	6.5	0.89
8-Jan-03	chum	55	49	10	5.0	1.20
20-Jan-03	chum	40	26	9	7.0	0.84
5-Feb-03	chum	0	7	0	6.0	1.34
Totals		***289***	***106***	***103***		

Table A-2. Date, species, number of live and dead salmon, and number of new redds, water temperature (°C) observed in Middle Goldsborough Creek, Washington, upstream of the Project Area (RM 2.3-3.4), 2002.

Date	Species	Live	Dead	Redds	Water Temp. (°C)
28-Aug-02	chum	0	0	0	16.0
11-Sep-02	chum	0	0	0	13.0
30-Sep-02	chum	0	0	0	11.0
14-Oct-02	chum	2	0	2	7.0
28-Oct-02	chum	0	0	0	9.0
11-Nov-02	chum	5	0	1	8.5
11-Nov-02	coho	2	0	1	8.5
18-Nov-02	chum	2	0	2	8.5
25-Nov-02	chum	0	0	1	7.0
9-Dec-02	chum	0	0	0	5.5
23-Dec-02	chum	4	0	0	7.0
8-Jan-03	chum	15	4	1	5.0
20-Jan-03	chum	0	3	0	7.0
5-Feb-03	chum	0	0	0	6.0
Totals		***30***	***7***	***8***	

Table A-3. Date, species, water temperature (°C), number of live and dead salmon, and number of new redds observed in Upper Goldsborough Creek, Washington (RM 5.8-6.7), 2002.

Date	Species	Live	Dead	Redds	Water Temp. (°C)
11-Sep-02	all	0	0	0	14.0
30-Sep-02	all	0	0	0	11.0
14-Oct-02	all	0	0	0	8.0
11-Nov-02	all	0	0	0	10.0
25-Nov-02	all	0	0	0	7.0
9-Dec-02	all	0	0	0	7.0
23-Dec-02	all	0	0	0	6.5
8-Jan-03	all	0	0	0	5.0
20-Jan-03	cutthroat	1	0	0	5.0
20-Jan-03	coho	0	0	1	6.0
5-Feb-03	all	0	0	0	5.0
Totals		***1***	***0***	***1***	

Table A-4. Date, species, water temperature (°C), number of live and dead salmon, and number of new redds observed in the South Fork Goldsborough Creek, Washington (RM 9.9-11.0), 2002.

Date	**Species**	**Live**	**Dead**	**Redds**	**Water Temp.(°C)**
11-Sep-02	all	0	0	0	14
30-Sep-02	all	0	0	0	
14-Oct-02	all	0	0	0	9
28-Oct-02	all	0	0	0	9
11-Nov-02	all	0	0	0	10
18-Nov-02	all	0	0	0	
25-Nov-02	all	0	0	0	7
9-Dec-02	all	0	0	0	5
23-Dec-02	all	0	0	0	
8-Jan-03	all	0	0	0	6
20-Jan-03	all	0	0	0	7
5-Feb-03	all	0	0	0	5
Totals		***0***	***0***	***0***	

Table A-5. Date, species, water temperature (°C), number of live and dead salmon, and number of new redds observed in Coffee Creek, Washington (RM 0.0-0.3), 2002.

Date	Species	Live	Dead	Redds	Water Temp.(°C)
28-Aug-02	chum	0	0	0	13.0
11-Sep-02	chum	0	0	0	14.0
30-Sep-02	chum	0	0	0	10.5
14-Oct-02	chum	0	0	0	6.5
28-Oct-02	chum	0	0	0	10.0
11-Nov-02	chum	1	0	0	8.0
11-Nov-02	coho	1	0	0	8.0
18-Nov-02	chum	14	1	4	8.0
25-Nov-02	chum	18	5	9	7.0
9-Dec-02	chum	17	10	4	6.0
23-Dec-02	chum	54	18	17	6.0
8-Jan-03	chum	79	36	6	4.0
20-Jan-03	chum	5	48	6	6.0
5-Feb-03	chum	0	5	0	
Totals		***189***	***123***	***46***	

Table A-6. Estimated coho and chum salmon escapement in two reaches of Goldsborough Creek, Washington, 1978-2002.

Year	Estimated Escapement		
	Coho RM 9.9-11.0[1]	**Chum RM 0.5-2.2**[2]	**Chum RM 2.3 –3.4**
1978	653	-	-
1979	898	-	-
1980	360	-	-
1981	1,259	-	-
1982	792	-	-
1983	228	-	-
1984	1,123	-	-
1985	630	-	-
1986	411	-	-
1987	598	14,479	-
1988	694	-	-
1989	48	5,843	-
1990	287	2,166	-
1991	22	2,687	-
1992	0	3,428	-
1993	0	5,250	-
1994	544	3,199	-
1995	74	1,283	-
1996	0	888	-
1997	128	405	-
1998	47	2,969	-
1999	0	239	0
2000	0	236	0
2001	0	248	84
2002	0		

[1] Zero indicates that no coho were observed in study section during that spawning year.

[2] Dash lines indicate that the study section was not surveyed during that spawning year.

APPENDIX B
Macroinvertebrate Data

Biological Monitoring
Goldsborough Creek, Washington
2002 Spawning and
Macroinvertebrate Surveys
Data Report

Benthic Invertebrate Index of Biological Integrity-BIBI (Kleindl 1995)

For R2 Resource Consultants, Inc., Redmond, Washington, by Aquatic Biology Associates, Inc., Corvallis, Oregon.
WA Department of Ecology sampling protocol, D-frame net, riffle, 4 point composite, 8 square feet, 500 micron mesh.
Aquatic Biology Associates, Inc. standard taxonomic effort (level 3).
Average densities adjusted to a square meter basis. Kleindl (1995) BIBI for Puget Lowland streams.

	Station	Goldsborough Cr. Site 1 Fall		Goldsborough Cr. Site 2 Fall		Goldsborough Cr. Site 3 Fall		Goldsborough Cr. Site 4 Fall	
	Date	October 14, 2002		October 14, 2002		October 14, 2002		October 14, 2002	
	METRIC	Value	Score	Value	Score	Value	Score	Value	Score
D	Total number of taxa	47	5	41	5	37	5	47	5
D	Number Ephemeroptera taxa	9	5	10	5	5	3	7	5
D	Number Plecoptera taxa	7	5	7	5	8	5	7	5
D	Number Trichoptera taxa	7	5	8	5	5	5	6	5
D	Number of intolerant taxa	2	3	2	3	1	3	2	3
D	Number of long-lived taxa	2	3	2	3	2	3	1	3
I	%Planaria & Amphipoda	0	5	0	5	0	5	0	5
I	% Tolerant taxa	23.85	3	30.79	3	17.97	5	18.14	5
D	% Predator	2.54	1	2.28	1	5.02	1	7.16	1
	TOTAL SCORE		35		35		35		37
	BIOLOGICAL CONDITION CATEGORY								

Maximum score of 45.

Each metric scored: 1=low, 3=moderate, 5=high

OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION

	Total abundance (m2)	19717		11217		25824		15801	
D	**EPT taxa richness**	23		25		18		20	
D	**Predator richness**	12		10		13		14	
D	**Scraper richness**	12		13		7		10	
D	**Shredder richness**	2		3		1		1	
D	**%Intolerant taxa**	0.2		0.43		0.47		0.76	

I	**Community tolerance (MHBI)**	4.34		3.37		3.71		3.72	
I	**% 3 dominant taxa**	65.6		73.1		66.25		59.52	
I	**%Collector**	71.92		52.94		65.47		53.16	
I	**%Parasite**	0.7		0.58		0.78		0.38	
I	**%Oligochaeta**	0.8		0.14		0.62		1.28	
I	**Number tolerant taxa**	2		2		2		2	
I	**%Simuliidae**	0.1		0.14		0.16		0.38	
I	**%Chironomidae**	20.8		9.64		9.69		25.67	

L,M & H comparisons with a Pacific Northwest montane stream with high biological integrity.

I= Metric value generally increases with declining biological integrity.
D= Metric value generally decreases with declining biological integrity.

		Total score
VP= very poor biological integrity		9-18
P= poor biological integegiry		18-24
F= fair biological integrity.		25-31
G= good biological integrity		32-38
E= excellent biological integrity.		39-45

Benthic Invertebrate Index of Biological Integrity-BIBI (Kleindl 1995)

For R2 Resource Consultants, Inc., Redmond, Washington, by Aquatic Biology Associates, Inc., Corvallis, Oregon.
WA Department of Ecology sampling protocol, D-frame net, riffle, 4 point composite, 8 square feet, 500 micron mesh.
Aquatic Biology Associates, Inc. standard taxonomic effort (level 3).
Average densities adjusted to a square meter basis. Kleindl (1995) BIBI for Puget Lowland streams.

	Station	**Goldsborough Cr. Site 1 Winter**		**Goldsborough Cr. Site 2 Winter**		**Goldsborough Cr. Site 3 Winter**		**Goldsborough Cr. Site 4 Winter**	
	Date	**February 25, 2003**		**February 25, 2003**		**February 25, 2003**		**February 25, 2003**	
	METRIC	**Value**	**Score**	**Value**	**Score**	**Value**	**Score**	**Value**	**Score**
D	**Total number of taxa**	48	5	51	5	59	5	55	5
D	**Number Ephemeroptera taxa**	9	5	9	5	11	5	10	5
D	**Number Plecoptera taxa**	7	5	9	5	10	5	9	5
D	**Number Trichoptera taxa**	7	5	8	5	10	5	10	5
D	**Number of intolerant taxa**	5	5	5	5	6	5	6	5
D	**Number of long-lived taxa**	4	5	5	5	3	5	4	5
I	**%Planaria & Amphipoda**	0	5	0	5	0	5	0	5
I	**% Tolerant taxa**	12.58	5	21.52	3	12.82	5	10.34	5
D	**% Predator**	7.71	1	6.06	1	8.51	1	13.31	1
	TOTAL SCORE		41		39		41		41
	BIOLOGICAL CONDITION CATEGORY								

Maximum score of 45.

Each metric scored: 1=low, 3=moderate, 5=high

OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION

	Total abundance (m2)	1155		4005		6771		1796	
D	**EPT taxa richness**	23		26		31		29	
D	**Predator richness**	15		13		14		15	
D	**Scraper richness**	16		17		18		18	
D	**Shredder richness**	3		4		4		5	
D	**%Intolerant taxa**	1.35		2.36		1.8		1.73	
I	**Community tolerance (MHBI)**	3.19		4.03		3.7		2.82	
I	**% 3 dominant taxa**	48.79		40.34		37.71		45.26	
I	**%Collector**	41.96		44.21		46.83		23.27	
I	**%Parasite**	0.3		0		0.15		0.37	
I	**%Oligochaeta**	1.06		2.86		1.34		0.37	
I	**Number tolerant taxa**	5		3		2		4	
I	**%Simuliidae**	1.36		4.54		0.89		0.25	
I	**%Chironomidae**	4.85		17.31		20.57		8.35	

L,M & H comparisons with a Pacific Northwest montane stream with high biological integrity.

I= Metric value generally increases with declining biological integrity.
D= Metric value generally decreases with declining biological integrity.

		Total score
VP= very poor biological integrity		9-18
P= poor biological integiry		18-24
F= fair biological integrity.		25-31
G= good biological integrity		32-38
E= excellent biological integrity.		39-45

Goldsborough Creek, Site 1, October 14, 2002

WA: Mason County, near Shelton, for R2 Resource Consultants, by ABA, Inc.
Benthic invertebrates, erosional habitat, D-frame net, 4 point, 8 ft 2, 500 micron.
Abundances converted to square meter basis. FILE: 02R201

IDENTIFICATION CODE	02R201
CORRECTION FACTOR	20.18

Taxon	Abundance	%
Nematoda	20	0.10
Oligochaeta	161	0.82
Acari	121	0.61
TOTAL: NON INSECTS	303	1.54
Acentrella turbida	222	1.13
Baetis tricaudatus	4561	23.13
Diphetor hageni	20	0.10
Drunella doddsi	20	0.10
Cinygmula	20	0.10
Epeorus longimanus	101	0.51
Ironodes	20	0.10
Rhithrogena	2684	13.61
Paraleptophlebia	383	1.94
TOTAL: EPHEMEROPTERA	8032	40.74
Capniidae	61	0.31
Sweltsa	61	0.31
Zapada cinctipes	565	2.87
Hesperoperla pacifica	40	0.20
Cultus	20	0.10
Isoperla	81	0.41
Skwala	40	0.20
TOTAL: PLECOPTERA	868	4.40
Brachycentrus americanus	242	1.23
Glossosoma	40	0.20
Hydropsyche	5691	28.86
Parapsyche almota	40	0.20
Rhyacophila Betteni Group	61	0.31
Rhyacophila Brunnea Group	20	0.10
Rhyacophila valuma	40	0.20
TOTAL: TRICHOPTERA	6135	31.12
Heterlimnius	81	0.41
Optioservus	141	0.72
TOTAL: COLEOPTERA	222	1.13

Goldsborough Cr., Site 1, Oct. 14, 2002, con't.

IDENTIFICATION CODE	02R201
CORRECTION FACTOR	20.18

Taxon	Abundance	%
Simulium	*20*	*0.10*
Cryptolabis	20	0.10
Hexatoma	20	0.10
TOTAL: DIPTERA	61	0.31
Chironomidae-pupae	585	2.97
Cardiocladius	20	0.10
Cladotanytarsus	2240	11.36
Cricotopus	40	0.20
Eukiefferiella	222	1.13
Eukiefferiella Devonica Group	81	0.41
Micropsectra	182	0.92
Nanocladius	20	0.10
Orthocladius Complex	363	1.84
Parametriocnemus	40	0.20
Polypedilum	101	0.51
Rheotanytarsus	20	0.10
Synorthocladius	61	0.31
Thienemanniella	40	0.20
Thienemannimyia Complex	61	0.31
Tvetenia Bavarica Group	20	0.10
TOTAL: CHIRONOMIDAE	4097	20.78
GRAND TOTAL	19716	100.00

Goldsborough Creek, Site 2, October 14, 2002

WA: Mason County, near Shelton, for R2 Resource Consultants, by ABA, Inc.
Benthic invertebrates, erosional habitat, D-frame net, 4 point, 8 ft 2, 500 micron.
Abundances converted to square meter basis. FILE: 02R203

IDENTIFICATION CODE	02R203
CORRECTION FACTOR	16.14

Taxon	Abundance	%
Nematoda	32	0.29
Oligochaeta	16	0.14
Acari	32	0.29
TOTAL: NON INSECTS	81	0.72
Acentrella turbida	32	0.29
Baetis tricaudatus	3309	29.50
Attenella delantala	16	0.14
Drunella doddsi	32	0.29
Ephemerella inermis/infrequens	32	0.29
Cinygmula	81	0.72
Epeorus longimanus	16	0.14
Ironodes	16	0.14
Rhithrogena	3454	30.79
Paraleptophlebia	129	1.15
TOTAL: EPHEMEROPTERA	7118	63.45
Capniidae	161	1.44
Zapada cinctipes	823	7.34
Calineuria californica	16	0.14
Hesperoperla pacifica	16	0.14
Cultus	16	0.14
Isoperla	48	0.43
Skwala	65	0.58
TOTAL: PLECOPTERA	1146	10.22
Brachycentrus americanus	32	0.29
Glossosoma	16	0.14
Hydropsyche	1436	12.81
Lepidostoma-panel case larvae	16	0.14
Rhyacophila Betteni Group	16	0.14
Rhyacophila Brunnea Group	16	0.14
Rhyacophila narvae	16	0.14
Neophylax rickeri	16	0.14
TOTAL: TRICHOPTERA	1566	13.96
Optioservus	145	1.29
TOTAL: COLEOPTERA	145	1.29

Goldsborough Cr., Site 2, Oct. 14, 2002, con't.

IDENTIFICATION CODE	02R203
CORRECTION FACTOR	16.14

Taxon	Abundance	%
Empididae	32	0.29
Chelifera	16	0.14
Simulium	16	0.14
Cryptolabis	16	0.14
TOTAL: DIPTERA	81	0.72
Chironomidae-pupae	97	0.86
Cladotanytarsus	839	7.48
Cricotopus	16	0.14
Micropsectra	16	0.14
Orthocladius Complex	16	0.14
Parametriocnemus	32	0.29
Polypedilum	32	0.29
Stempellinella	32	0.29
TOTAL: CHIRONOMIDAE	1081	9.64
GRAND TOTAL	11217	100.00

Goldsborough Creek, Site 3, October 14, 2002

WA: Mason County, near Shelton, for R2 Resource Consultants, by ABA, Inc.
Benthic invertebrates, erosional habitat, D-frame net, 4 point, 8 ft 2, 500 micron.
Abundances converted to square meter basis. FILE: 02R205

IDENTIFICATION CODE	02R205
CORRECTION FACTOR	40.35

Taxon	Abundance	%
Oligochaeta	161	0.63
Acari	202	0.78
TOTAL: NON INSECTS	363	1.41
Baetis tricaudatus	3954	15.31
Attenella delantala	81	0.31
Ephemerella inermis/infrequens	121	0.47
Rhithrogena	3349	12.97
Paraleptophlebia	121	0.47
TOTAL: EPHEMEROPTERA	7626	29.53
Capniidae	40	0.16
Chloroperlidae	40	0.16
Sweltsa	363	1.41
Zapada cinctipes	2663	10.31
Calineuria californica	40	0.16
Hesperoperla pacifica	81	0.31
Isoperla	242	0.94
Skwala	81	0.31
TOTAL: PLECOPTERA	3551	13.75
Brachycentrus americanus	202	0.78
Hydropsyche	9805	37.97
Rhyacophila Betteni Group	81	0.31
Rhyacophila Brunnea Group	40	0.16
Rhyacophila valuma	40	0.16
TOTAL: TRICHOPTERA	10168	39.38
Heterlimnius	404	1.56
Optioservus	686	2.66
TOTAL: COLEOPTERA	1089	4.22

Goldsborough Cr., Site 3, Oct. 14, 2002, con't

IDENTIFICATION CODE	02R205
CORRECTION FACTOR	40.35

Taxon	Abundance	%
Empididae	40	0.16
Chelifera	81	0.31
Glutops	121	0.47
Simulium	40	0.16
Antocha	121	0.47
Cryptolabis	81	0.31
Dicranota	40	0.16
TOTAL: DIPTERA	525	2.03
Chironomidae-pupae	323	1.25
Cladotanytarsus	1372	5.31
Cricotopus	40	0.16
Eukiefferiella	40	0.16
Orthocladius Complex	565	2.19
Polypedilum	40	0.16
Synorthocladius	40	0.16
Tvetenia Bavarica Group	81	0.31
TOTAL: CHIRONOMIDAE	2502	9.69
GRAND TOTAL	25824	100.00

Goldsborough Creek, Site 4, October 14, 2002

WA: Mason County, near Shelton, for R2 Resource Consultants, by ABA, Inc.
Benthic invertebrates, erosional habitat, D-frame net, 4 point, 8 ft 2, 500 micron.
Abundances converted to square meter basis. FILE: 02R207

IDENTIFICATION CODE	02R207
CORRECTION FACTOR	20.18

Taxon	Abundance	%
Oligochaeta	202	1.28
Acari	61	0.38
TOTAL: NON INSECTS	262	1.66
Acentrella turbida	121	0.77
Baetis tricaudatus	2845	18.01
Diphetor hageni	20	0.13
Ephemerella inermis/infrequens	40	0.26
Epeorus longimanus	242	1.53
Rhithrogena	4319	27.33
Paraleptophlebia	161	1.02
TOTAL: EPHEMEROPTERA	7749	49.04
Chloroperlidae	20	0.13
Sweltsa	424	2.68
Zapada cinctipes	303	1.92
Hesperoperla pacifica	40	0.26
Cultus	61	0.38
Isoperla	101	0.64
Skwala	61	0.38
TOTAL: PLECOPTERA	1009	6.39
Brachycentrus americanus	141	0.89
Glossosoma	40	0.26
Hydropsyche	1836	11.62
Rhyacophila Betteni Group	161	1.02
Rhyacophila narvae	40	0.26
Rhyacophila valuma	81	0.51
TOTAL: TRICHOPTERA	2301	14.56
Optioservus	20	0.13
Hydrophilidae	20	0.13
TOTAL: COLEOPTERA	40	0.26

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Goldsborough Cr., Site 4, Oct. 14, 2002, con't.

IDENTIFICATION CODE	02R207
CORRECTION FACTOR	20.18

Taxon	Abundance	%
Glutops	61	0.38
Pericoma	20	0.13
Simulium	61	0.38
Antocha	61	0.38
Cryptolabis	161	1.02
Hexatoma	20	0.13
TOTAL: DIPTERA	383	2.43
Chironomidae-pupae	585	3.70
Cardiocladius	20	0.13
Cladotanytarsus	2240	14.18
Eukiefferiella	182	1.15
Heleniella	20	0.13
Lopescladius	40	0.26
Micropsectra	383	2.43
Nanocladius	20	0.13
Orthocladius Complex	61	0.38
Orthocladius	40	0.26
Parametriocnemus	20	0.13
Polypedilum	141	0.89
Rheotanytarsus	20	0.13
Stempellinella	61	0.38
Tanytarsus	20	0.13
Thienemannimyia Complex	20	0.13
Tvetenia Bavarica Group	182	1.15
TOTAL: CHIRONOMIDAE	4056	25.67
GRAND TOTAL	15801	100.00

Goldsborough Creek, Site 1, February 25, 2003

WA: Mason County, near Shelton, for R2 Resource Consultants, by ABA, Inc.
Benthic invertebrates, erosional habitat, D-frame net, 4 point, 8 ft 2, 500 micron.
Abundances converted to square meter basis. FILE: 03R202

IDENTIFICATION CODE	03R202
CORRECTION FACTOR	1.75

Taxon	Abundance	%
Oligochaeta	12	1.06
Juga	7	0.61
Acari	4	0.30
TOTAL: NON INSECTS	23	1.97
Baetis tricaudatus	116	10.00
Attenella delantala	18	1.52
Drunella coloradensis/flavilinea	5	0.45
Drunella doddsi	2	0.15
Ephemerella inermis/infrequens	19	1.67
Cinygmula	163	14.09
Epeorus longimanus	56	4.85
Rhithrogena	138	11.97
Paraleptophlebia	4	0.30
TOTAL: EPHEMEROPTERA	520	45.00
Capniidae	2	0.15
Chloroperlidae	2	0.15
Sweltsa	18	1.52
Calineuria californica	2	0.15
Hesperoperla pacifica	16	1.36
Cultus	5	0.45
Taenionema	114	9.85
TOTAL: PLECOPTERA	158	13.64
Brachycentrus americanus	23	1.97
Glossosoma	23	1.97
Hydropsyche	263	22.73
Dicosmoecus gilvipes	2	0.15
Rhyacophila Angelita Group	4	0.30
Rhyacophila Betteni Group	12	1.06
Rhyacophila narvae	11	0.91
TOTAL: TRICHOPTERA	336	29.09

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Goldsborough Cr., Site 1, Feb. 25, 2003, con't.

IDENTIFICATION CODE	03R202
CORRECTION FACTOR	1.75

Taxon	Abundance	%
Heterlimnius	7	0.61
Narpus	2	0.15
Optioservus	19	1.67
Zaitzevia	2	0.15
TOTAL: COLEOPTERA	30	2.58
Ceratopogoninae	2	0.15
Chelifera	7	0.61
Hemerodromia	2	0.15
Wiedemannia	2	0.15
Glutops	4	0.30
Simulium	16	1.36
Antocha	2	0.15
TOTAL: DIPTERA	33	2.88
Chironomidae-pupae	4	0.30
Cardiocladius	2	0.15
Cladotanytarsus	4	0.30
Eukiefferiella	18	1.52
Heleniella	9	0.76
Krenosmittia	2	0.15
Pagastia	4	0.30
Stempellinella	2	0.15
Thienemanniella	4	0.30
Thienemannimyia Complex	4	0.30
Tvetenia Bavarica Group	7	0.61
TOTAL: CHIRONOMIDAE	56	4.85
GRAND TOTAL	1155	100.00

Goldsborough Creek, Site 2, February 25, 2003

WA: Mason County, near Shelton, for R2 Resource Consultants, by ABA, Inc.
Benthic invertebrates, erosional habitat, D-frame net, 4 point, 8 ft 2, 500 micron.
Abundances converted to square meter basis. FILE: 03R204

IDENTIFICATION CODE	03R204
CORRECTION FACTOR	6.73

Taxon	Abundance	%
Oligochaeta	114	2.86
Juga	7	0.17
TOTAL: NON INSECTS	121	3.03
Ameletus	7	0.17
Baetis tricaudatus	747	18.66
Attenella delantala	34	0.84
Drunella coloradensis/flavilinea	27	0.67
Drunella doddsi	7	0.17
Ephemerella inermis/infrequens	54	1.34
Cinygmula	518	12.94
Epeorus longimanus	242	6.05
Rhithrogena	350	8.74
TOTAL: EPHEMEROPTERA	1985	49.58
Capniidae	27	0.67
Chloroperlidae	20	0.50
Sweltsa	34	0.84
Calineuria californica	7	0.17
Hesperoperla pacifica	20	0.50
Cultus	27	0.67
Isoperla	13	0.34
Pteronarcys californica	13	0.34
Taenionema	262	6.55
TOTAL: PLECOPTERA	424	10.59
Brachycentrus americanus	13	0.34
Glossosoma	13	0.34
Hydropsyche	229	5.71
Dicosmoecus gilvipes	20	0.50
Rhyacophila Angelita Group	7	0.17
Rhyacophila Betteni Group	7	0.17
Rhyacophila narvae	7	0.17
Neophylax	87	2.18
TOTAL: TRICHOPTERA	384	9.58

Goldsborough Cr., Site 2, Feb. 25, 2003, con't.

IDENTIFICATION CODE	03R204
CORRECTION FACTOR	6.73

Taxon	Abundance	%
Narpus	7	0.17
Optioservus	108	2.69
TOTAL: COLEOPTERA	114	2.86
Ceratopogoninae	13	0.34
Chelifera	34	0.84
Glutops	7	0.17
Pericoma	7	0.17
Simulium	182	4.54
Antocha	13	0.34
Cryptolabis	27	0.67
TOTAL: DIPTERA	283	7.06
Chironomidae-pupae	34	0.84
Cladotanytarsus	128	3.19
Eukiefferiella	148	3.70
Heleniella	40	1.01
Krenosmittia	47	1.18
Orthocladius Complex	7	0.17
Pagastia	7	0.17
Paraphaenocladius	7	0.17
Polypedilum	54	1.34
Rheocricotopus	7	0.17
Stempellinella	20	0.50
Thienemanniella	87	2.18
Thienemannimyia Complex	47	1.18
Tvetenia Bavarica Group	61	1.51
TOTAL: CHIRONOMIDAE	693	17.31
GRAND TOTAL	4004	100.00

Goldsborough Creek, Site 3, February 25, 2003

WA: Mason County, near Shelton, for R2 Resource Consultants, by ABA, Inc.
Benthic invertebrates, erosional habitat, D-frame net, 4 point, 8 ft 2, 500 micron.
Abundances converted to square meter basis. FILE: 03R206

IDENTIFICATION CODE	03R206
CORRECTION FACTOR	10.09

Taxon	Abundance	%
Oligochaeta	91	1.34
Acari	10	0.15
TOTAL: NON INSECTS	101	1.49
Ameletus	20	0.30
Baetis tricaudatus	817	12.07
Diphetor hageni	20	0.30
Attenella delantala	91	1.34
Drunella coloradensis/flavilinea	91	1.34
Drunella doddsi	10	0.15
Ephemerella inermis/infrequens	111	1.64
Cinygmula	878	12.97
Epeorus longimanus	777	11.48
Rhithrogena	404	5.96
Paraleptophlebia	30	0.45
TOTAL: EPHEMEROPTERA	3249	47.99
Capniidae	10	0.15
Chloroperlidae	71	1.04
Sweltsa	50	0.75
Leuctridae	10	0.15
Malenka	20	0.30
Calineuria californica	20	0.30
Hesperoperla pacifica	10	0.15
Cultus	20	0.30
Isoperla	20	0.30
Taenionema	272	4.02
TOTAL: PLECOPTERA	505	7.45
Amiocentrus aspilus	10	0.15
Brachycentrus americanus	30	0.45
Glossosoma	40	0.60
Hydropsyche	858	12.67
Dicosmoecus gilvipes	30	0.45
Rhyacophila Angelita Group	30	0.45

Goldsborough Cr., Site 3, Feb. 25, 2003, con't.

IDENTIFICATION CODE	03R206
CORRECTION FACTOR	10.09

Taxon	Abundance	%
Rhyacophila Betteni Group	91	1.34
Rhyacophila Brunnea Group	20	0.30
Rhyacophila narvae	10	0.15
Neophylax	30	0.45
TOTAL: TRICHOPTERA	1150	16.99
Narpus	10	0.15
Optioservus	50	0.75
TOTAL: COLEOPTERA	61	0.89
Chelifera	91	1.34
Clinocera	10	0.15
Glutops	10	0.15
Pericoma	10	0.15
Simulium	61	0.89
Antocha	131	1.94
TOTAL: DIPTERA	313	4.62
Chironomidae-pupae	91	1.34
Cladotanytarsus	40	0.60
Eukiefferiella	222	3.28
Heleniella	40	0.60
Krenosmittia	50	0.75
Micropsectra	111	1.64
Orthocladius Complex	212	3.13
Pagastia	20	0.30
Parametriocnemus	50	0.75
Paraphaenocladius	20	0.30
Polypedilum	30	0.45
Rheotanytarsus	50	0.75
Stempellinella	81	1.19
Synorthocladius	10	0.15
Tanytarsus	81	1.19
Thienemanniella	30	0.45
Thienemannimyia Complex	121	1.79
Tvetenia Bavarica Group	131	1.94
TOTAL: CHIRONOMIDAE	1392	20.57
GRAND TOTAL	6770	100.00

Goldsborough Creek, Site 4, February 25, 2003

WA: Mason County, near Shelton, for R2 Resource Consultants, by ABA, Inc.
Benthic invertebrates, erosional habitat, D-frame net, 4 point, 8 ft 2, 500 micron.
Abundances converted to square meter basis. FILE: 03R208

IDENTIFICATION CODE	03R208
CORRECTION FACTOR	2.24

Taxon	Abundance	%
Oligochaeta	7	0.37
Juga	2	0.12
Acari	7	0.37
TOTAL: NON INSECTS	16	0.87
Baetis tricaudatus	168	9.35
Diphetor hageni	2	0.12
Attenella delantala	13	0.75
Drunella coloradensis/flavilinea	7	0.37
Drunella doddsi	2	0.12
Ephemerella inermis/infrequens	25	1.37
Cinygmula	293	16.33
Epeorus longimanus	159	8.85
Rhithrogena	352	19.58
Paraleptophlebia	2	0.12
TOTAL: EPHEMEROPTERA	1024	56.98
Chloroperlidae	18	1.00
Sweltsa	74	4.11
Leuctridae	2	0.12
Calineuria californica	11	0.62
Hesperoperla pacifica	7	0.37
Cultus	9	0.50
Isoperla	4	0.25
Pteronarcys californica	2	0.12
Taenionema	76	4.24
TOTAL: PLECOPTERA	204	11.35
Brachycentrus americanus	2	0.12
Micrasema	2	0.12
Glossosoma	11	0.62
Hydropsyche	69	3.87
Dicosmoecus gilvipes	11	0.62

Goldsborough Cr., Site 4, Feb. 25, 2003, con't.

IDENTIFICATION CODE	03R208
CORRECTION FACTOR	2.24

Taxon	Abundance	%
Rhyacophila Angelita Group	11	0.62
Rhyacophila Betteni Group	25	1.37
Rhyacophila narvae	13	0.75
Rhyacophila valuma	9	0.50
Neophylax	2	0.12
TOTAL: TRICHOPTERA	157	8.73
Heterlimnius	7	0.37
Optioservus	13	0.75
TOTAL: COLEOPTERA	20	1.12
Ceratopogoninae	11	0.62
Chelifera	40	2.24
Hemerodromia	2	0.12
Glutops	2	0.12
Pericoma	2	0.12
Simulium	4	0.25
Antocha	2	0.12
Cryptolabis	161	8.98
TOTAL: DIPTERA	226	12.59
Chironomidae-pupae	11	0.62
Brillia	2	0.12
Cladotanytarsus	11	0.62
Eukiefferiella	7	0.37
Heleniella	16	0.87
Krenosmittia	13	0.75
Micropsectra	13	0.75
Pagastia	2	0.12
Parametriocnemus	40	2.24
Paraphaenocladius	11	0.62
Stempellinella	4	0.25
Thienemannimyia Complex	2	0.12
Tvetenia Bavarica Group	16	0.87
TOTAL: CHIRONOMIDAE	150	8.35
GRAND TOTAL	1796	100.00